# Manual Of Style

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*Updated 2-9-16*

# CHAPTER 1 GENERAL PROVISIONS

### 101.0 Scope.

**101.1 General.** Chapter 1 addresses the structure of IAPMO American National Standard that includes the physical layout of the documents, numbering system, and chapter sequences.

### 102.0 Codes and Standards.

**102.1 General.** The main text of a code shall consist of all mandatory requirements (see definition of standard in Appendix A, Section 2.0).

**102.2 Location.** Nonmandatory provisions shall be located in an appendix, footnote, or fine-print note and are not considered part of the requirements of a code.

### 103.0 Code Division.

**103.1 Chapters and Appendices.** Codes shall consist of specific chapters and appendices, which shall be further subdivided into sections, subsections, paragraphs, and subparagraphs.

**103.2 Components.** Codes shall contain in order a cover; title page; copyright; edition; publisher; important notices and disclaimers; updating IAPMO codes; foreword; origin and development; adoption; revision markings; format of the code (arrangement of chapters, scope, and intent of the provisions addressed within each chapter and appendices); sample legislation for adoption of the code; membership of committee and classification; section relocation and table of contents.

**103.3 Cover.** The front cover shall carry the IAPMO numeric designation for that code; the title of the document; the IAPMO logo; and additional logos of supporting organizations, as applicable. Documents approved by the American National Standards Institute (ANSI) shall have a statement to this effect by noting, "An American National Standard," IAPMO/ANSI document name followed by 1 and year of the document.

**103.4 Inside Cover.** The inside of the front cover shall be blank.

**103.5 Title Page.** The title page shall contain the same information as the cover except logos of supporting organizations.

**103.6 Copyright, Edition, and Publisher.** Copyright shall contain year, publisher and statement prohibiting recording or reproducing any work without permission from the publisher. The edition, number of printings and date shall follow the copyright information. The publisher contact information shall include the address, phone and fax number.

**103.7 Important Notices and Disclaimers.** Notices shall include the consensus development process, disclaimer for liability for injury, property, or other damages resulting from the publication, guarantee or warranty to the accuracy of completeness, and the exercise of reasonable care in any given circumstance when using this document.

**103.8 Updating IAPMO Codes.** IAPMO codes may be amended from time to time through the issuance of Tentative Interim Amendments or corrected by Errata. IAPMO codes consist of the current edition of the document together with any Tentative Interim Amendment and any Errata in effect.

**103.9 Foreword.** The foreword shall contain an origin and development statement, adoption information and revision markings.

**103.9.1 Origin and Development.** The origin and development statement shall reference its first edition, including the purpose, scope and supporting organizations. The development shall include information on the open consensus process under ANSI with each three-year revision code cycle under four basic steps including the public and committee proposal stage, comment stage, association technical meeting, council appeals and issuance of the code.

**103.9.2 Adoption.** The adoption section provides reference for its use within a governmental jurisdiction through the adoption by reference of applicable jurisdictional laws. The sample ordinance provides key components, regulations, and resolutions.

**103.9.3 Revision Markings.** Revisions to the code are noted with a solid vertical line in the margin indicate a technical change from the requirements of the previous edition. An arrow (⟷) in the margin indicates where an entire section, paragraph, exception, table, or a list has been deleted.
A double right angle (**»**) in the margin indicates that the text or a table is relocated within the code. The table found after the committee page points out the relocations in the current edition from the previous edition of the code.
A reference in brackets [ ] following a section or paragraph indicates the material is extracted from another document. This reprinted material is not the complete and official position of the source document on the referenced subject.
Text that is extracted pursuant to IAPMO's Extract Guidelines, but outside of the regular revision process is denoted by the use of the source document in the margin. IAPMO does not fully process this text by ANSI's public announcement consensus requirements for an American National Standard (ANS) nor approved by ANSI's Board of Standards Review. The next revision cycle processes such text by those requirements.

**103.10 Format of IAPMO Codes.** The format of IAPMO codes is arranged by each chapter based on a particular subject matter. The subject matters included in the table indicates each chapter and corresponding subject matter. The following page provides a summary of the scope and intent of the provisions addressed within the chapters and appendices for each code.

**103.11 Sample Legislation for Adoption of IAPMO Codes.** IAPMO codes are intended to be adopted by jurisdictions through an ordinance. The sample ordinance is a guide for drafting an ordinance for adoption that addresses key components, regulations, and resolutions. At adoption, jurisdictions should insert the applicable information in bracketed words.

**103.12 Committee Members.** The page following the sample ordinance shall provide the committee list(s) of all persons who were committee members at the time of the final committee balloting of the specific edition of the document. The IAPMO Standards Council names shall be listed at the top of the page and include the members of the Council. The technical committee, along with the company or organization they represent and their member classification shall follow. The technical committee is organized by committee officers (chair and secretary); principal; alternate; and nonvoting members.
A statement shall include that this list represents the membership at the time the committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred.

**103.12.1 Responsible Committee.** When more than one technical committee is responsible for the document, all committees shall be listed with an indication of the portion of the document for which each technical committee is responsible.

**103.13 Section Relocation.** A table shall follow the committee members and indicate sections relocated from the previous edition of the code to the most recent edition of the code. The current year shall be in the first column followed by the previous edition of the code.

**104.0 Table of Contents.**

**104.1 Format.** The table of contents shall start on the right side of the book, following the section relocation pages. This page shall be set in two columns.

**104.2 Title/Section.** The table of contents shall itemize all chapter titles and section headings appearing in the document and the pages on which they start; except the appendices.

**104.3 Designations.** Chapter designations and titles shall be in caps and boldface type. The section designations shall be 9-point font size in upper/lower case Helvetica. Page numbers are boldface for chapter titles (**CHAPTER 1 ADMINISTRATION**) shall be Helvetica 9 point font size.

**104.4 Layout.** To facilitate the compilation of the table of contents, each main section with a title shall be included (e.g., three digit number followed by one number in sequential order; 101.0 General, 102.0 Applicability, 103.0 Duties and Powers of the Authority Having Jurisdiction).

**104.5 Chapter.** The first page of the document shall begin on the right side of the book on the next full page following the end of the table of contents.

# CHAPTER 2 ADMINISTRATION

**201.0 Administration.**

**201.1 General.** Chapter 1 shall include a title, scope, and purpose.

**201.2 Title.** The document shall start with a statement of the title and citation.

**201.3 Purpose.** The purpose shall describe the goal and objectives of the document.

**201.4 Scope.** The scope shall describe in general terms what it covers in sufficient detail and any limitations.

**202.0 Chapter 2 Definitions.**

**202.1 General.** All definitions contained within the document shall appear in Chapter 2 and written in non-mandatory language.

**202.2 Location of Definitions.** Chapter 2 shall include definitions numbered in alphabetical order.

**203.0 Referenced Standards Table.**

**203.1 Applicable References.** The Referenced Standards Table shall comply with the IAPMO Regulations Governing Committee Projects Section 3-3.7 Reference Standards and Publications.

**203.2 Mandatory References.** Mandatory standards or publications referenced in IAPMO Codes shall be written using mandatory language and identified by the name of the developing organization, title, date or edition. Each standard shall include the referenced section that applies.

**203.3 Nonmandatory References.** Any standards or references that are not mandatory but apply to the document shall be included in accordance with IAPMO Regulations Governing Committee Projects (Section 3-3.7.2 through 3-3.7.4).

**204.0 Individual Chapter Administrative Text.**

**204.1 Numbering System.** The text is divided into chapters that are numbered consecutively with Arabic numbers followed by the title.

**204.2 Sections.** Mandatory text within chapters are divided into sections that are numbered consecutively.

**204.2.1 Titles.** All sections are titled and prepared by IAPMO independent of the consensus development process.

**204.2.2 Numbering Sections.** Sections shall be numbered consecutively by adding a period (.) and an Arabic number after the chapter number (e.g., sections in Chapter 5 shall be numbered 501.0, 502.0, 503.0, 504.0, 505.0, 505.0, 506.0, 507.0)

**204.2.3 Subsections.** Sections containing multiple requirements shall be subdivided into subsections, and further subdivided into paragraphs of text. All subsections are titled and prepared by IAPMO independent of the consensus development process.

**204.2.4 Numbering Subsections.** Subsections are numbered consecutively by adding a period and a number to the section number (e.g., subsections in Section 507.0 are numbered 507.1, 507.2, 507.3, 507.4, 507.5, 507.6, etc.).

**204.2.5 Numbering Paragraphs.** Paragraphs are numbered by adding a period and consecutive number to the subsection number (e.g., subsections in Section 507.1 shall be numbered 507.1.1, 507.1.2, 507.1.3, 507.1.4, etc.).

**204.2.6 Numbering Subparagraphs.** Subparagraphs shall be numbered by adding a period and consecutive numbers to the paragraph number (e.g., 507.1.1.1, 507.1.1.2, 507.1.1.3, 507.1.1.4, etc). The total number of digits, including the chapter number designator, shall not exceed six digits [e.g., 507.1.1.1].

### 205.0 Appendices.

**205.1 General.** The provisions in the appendices are intended to supplement the requirements of this document and shall not be considered part of this document unless formally adopted as such. Appendices shall be within the scope under which the document was developed, and they shall not be inconsistent with the document itself.

**205.2 Regulation of Appendices.** Appendices are processed in accordance with the Regulations Governing Committee Projects.
**Exception:** Appendix I Installation Standards.

**205.3 Content.** Appendices shall begin with its designation (e.g., Appendix A101.0, B101.0, C101.0), title, and shall include applicable scopes, purposes, applications, and references as required. Definitions cited in the appendices shall be located in Chapter 2.

**205.4 Mandatory Language.** Appendices are written in mandatory language as adoptable by the Authority Having Jurisdiction.

### 206.0 Installation Standards.

**206.1 General.** The following two editorial statements for Appendix I shall consist of the following:
*"The information contained in this appendix is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, this appendix may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard."*

**206.2 Title designation.** The following shall be located after title designation for Appendix I:
*The following IAPMO Installation Standards are included here for the convenience of the users of the [document name]. They are not considered as a part of [document name] unless formally adopted as such. These Installation Standards are independent, stand-alone documents published by the International Association of Plumbing and Mechanical Officials and are printed herein by the expressed written permission of IAPMO.*

### 207.0 Extract Guidelines.

**207.1 General.** These guidelines are for extracting text between IAPMO and other ANSI-accredited standards developing organizations that are working to harmonize and coordinate their respective documents. The Extract Guidelines are meant to supplement but not conflict with IAPMO's Regulations Governing Committee Projects.

**207.2 General Guidance.** A document may contain text extracted from another standard developing organization's document provided:
(1) There is good and sufficient reason for the extracts;
(2) There is clear indication, with the extracted text, of the number, title, and edition of the document from which the extracts originate from and that requests for interpretations or proposed revisions of the text must be referred to the committee responsible for the source document;
(3) Any editing of the extracted text is confined only to making the style consistent with that of the document containing the extract and then only with the concurrence of the committee responsible for the source document; and
(4) The extracted text is kept current with that of the source document.

**207.3 Updating Extracts.** The extracted text shall be current with that of the source document. In most cases an update to the extracted text may be accomplished via a proposal or a comment during the regular revision process of the document. If no proposal to update the extracted text is received, the committee responsible for the document shall update the document in which the extracted text appears during its next regular revision process.

**207.4 Conflict.** It may be necessary to update extracted text before the next regular revision cycle of the document if the change in the text of the document of origin results in a major conflict between the documents. If a request is received to update an extract before the next regular revision cycle of the document containing the extracted text, such a request shall be submitted to the IAPMO Standards Council Secretary who, after consultation with the appropriate committee chair, shall determine whether it is eligible for processing.

**207.4.1 Letter Ballot.** If the extract is determined to be eligible for processing, the staff liaison shall letter ballot the extracting committee in accordance with the Regulations Governing Committee Projects on the updating of the extracted text, including any editorial revisions necessary to conform to the style of the document.

**Note:** If the extract needs to be editorially revised to fit the language of the document in which it is to appear, the staff liaison for the committee responsible for the document of origin shall contact the source committee to verify that the intent of the extract has not been changed.

**207.4.2 Media Coverage.** A proposed extract shall be published in the appropriate media with a notice that the proposed extract has been forwarded to the responsible Technical Committee for processing and that anyone interested may comment on the proposed extract within the published timeline.

**207.4.3 Ballot Results.** The ballot results, including any negative ballots and the reasons for the negatives, as well as public comments shall be forwarded to the IAPMO Standards Council to determine whether or not to issue the extract update.

**207.4.4 Publishing Extract.** Extracts which are processed under these Guidelines, but outside of the regular revision process of the document shall be designated in the document as follows:

*A reference bracket [ ] following a section or paragraph indicates material that has been extracted from another document. This reprinted material is not the complete and official position of the source document on the reference subject, which is represented by the standard in its entirety. Text, which has been extracted pursuant to IAPMO's Extract Guidelines, is denoted with the use of the source document in the margin. This text has not been fully processed by IAPMO in accordance with ANSI's public announcement consensus requirements for an American National Standard (ANS) nor approved by ANSI's Board of Standards Review, but will be fully processed in accordance with those requirements as part of the next revision cycle for this document.*

If the technical committee does not wish to include the updated extract, the committee shall delete the existing extract from its document using a Tentative Interim Amendment (see Regulations Governing Committee Projects); or if the document is in the process of revision, by the normal processing of an amendment.

**207.5 Extraction of Text.** The guidance for the extraction of text from one document to another shall be in accordance with Sections 207.5.1 through 207.5.6.

**207.5.1 General.** The intent of the extracting text is to make a document as complete and useful as possible. Care must be taken not to compromise the intent of the criterion being extracted.
A section or paragraph being extracted from another document represents a specific thought, and it is important that the thought in its entirety be extracted. The context of the original extracted material should not be compromised or violated.

**207.5.2 Exception and Caution Statements.** Text should not be extracted without including any exception(s) associated with the extracted text. Likewise, caution statements should also be included. Exception and caution statements are considered part of the requirements of the associated paragraph.

**207.5.3 Paragraph Numbering.** Committees need to be careful not to change the relationship of paragraphs to each other in the way they renumber extracted text. For example, if a paragraph with 2 subparagraphs is renumbered as 3 separate and distinct paragraphs, does that change the relationship of paragraph 2 and 3 to the original paragraph 1. Many times subparagraphs refine requirements in the host paragraph and renumbering will change that emphasis, and possibly compromise that relationship. For example:

| **Parent Document** | **Document Extracting** |
|---|---|
| 705.1 Paragraph | 802.3.1 Paragraph |
| 705.1.1 Subparagraph | 802.3.2 Paragraph |
| 705.1.2 Subparagraph | 802.3.3 Paragraph |
| 705.2 Paragraph | 802.3.4 Paragraph |

The committee taking the extract shall be very careful not to take part of a section or paragraph and skip another part of the same section or paragraph (e.g., take 705.1, 705.1.1, and 705.1.3, but not take 705.1.2) without a valid reason. This can be misleading as the user will think they have the complete text, and the extracted text may be used out of context. The family of paragraphs that state a set of requirements should be kept together to ensure both documents are consistent in stated requirements.

**207.5.4 References.** Where extracted material references another paragraph in the document from which the material is extracted, the committee shall extract the referenced paragraph, so their document is complete and user-friendly. The intent of the extracting text is to make a document as complete and useful as possible. Sending someone back to another document for a referenced paragraph is not user-friendly.

**207.5.5 Notes and Related Appendices.** Notes and appendices are intended as advisory, supplemental information, and thus, they may or may not be included along with an extracted paragraph. If the extracted text contains "Notes" in the parent document, the committee should carefully review the notes. If the committee chooses not to extract the note, they shall be sure that the paragraph cannot be misinterpreted based on the absence of this supplemental information.

**207.5.6 Placement of Extract References.** References to text extracted from another document shall be located at the end of the extracted text.

For example,
**507.15 Installation in Aircraft Hangars.** Heaters in aircraft hangars shall be installed in accordance with NFPA 409. [NFPA 54:9.1.12]
Or
**508.2.2 Electrical Power.** Appliances requiring an external source of electrical power for its operation shall be provided with:
(1) A readily accessible electrical disconnecting means within sight of the appliance that will completely de-energize the appliance.
(2) A 120-VAC grounding-type receptacle outlet on the roof adjacent to the appliance. The receptacle outlet shall be on the supply side of the disconnect switch. [NFPA 54:9.4.2.3]

### 208.0 Index.

**208.1 General.** All IAPMO Technical Committee documents shall have an index that shall be prepared by IAPMO independent of the consensus development process.

# CHAPTER 3 TECHNICAL STYLE

### 301.0 Technical Style.

**301.1 General.** Chapter 3 of this document addresses the technical style of the document and shall include the following:
(1) Technical rules;
(2) Rules for mandatory documents;
(3) Rules for nonmandatory documents.

### 302.0 Technical Rules.

**302.1 Permissive or Alternative Terms.** The terms *may* and *may not* shall not be used in any portion of codes, standards, or recommended practices.

**302.2 Permitted Use.** The phrase *shall be permitted (to be)* shall be used to state a permitted use or an alternative to a specified requirement within the code.

**302.3 Unenforceable Terms.** The main text of codes and standards shall not contain references or requirements that are unenforceable and vague (see Table 302.3).

**302.4 Recommended Guides.** Unenforceable terms may be used in recommended practices and guides.

**302.5 Context.** The terms contained in Table 302.3 shall be reviewed in context, and if the resulting requirement is unenforceable or vague, they shall not be used within the body of codes or standards.

**302.6 List of Terms.** The list of terms contained in Table 302.3 and Table 305.0 shall not be considered all-inclusive (see Appendix A, Table A 3.0 for additional terms and use).

**TABLE 302.3**
**POSSIBLE UNENFORCEABLE AND VAGUE TERMS**

| | | | | |
|---|---|---|---|---|
| Acceptable | Desire | Imply | Periodic | Secure |
| Adequate | Easy | Infer | Possible | Several |
| Advise | Effectively | Legible | Practical | Should |
| Appreciable | Encourage | Lightly | Practices | Significant |
| Appropriate | Equivalent | Likely | Prefer | Similar |
| Approximate | Familiar | Many | Presume | Some |
| Aspire | Feasible | May | Probable | Substantial |
| Available | Few | Maybe | Proper | Sufficient |
| Avoid | Firmly | Might | Ready | Suggest |
| Can | Frequent | Most | Reasonable | Suggestion |
| Care | Generally | Near | Recommend | Suitable |
| Careful | Good | Neat | Recommendation | Urge |
| Chance | Grant | Normal | Request | Usual |
| Consider | Guide | Note | Safe | Workmanlike |
| Could | Guideline | Ought | Satisfactory | Would |

**302.7 Language.** All mandatory language shall be reviewed for usability, adoptability, and enforceability.

### 303.0 Health and Safety.

**303.1 Standard Content**. The scope or application of a standard shall be clearly described. Codes and standards shall state specific criteria that minimize the judgment required by the users. The standard shall not have the effect of requiring proprietary materials. The standard shall not prescribe a proprietary agency for quality control or testing. The measure of performance for which the test is conducted shall be clearly defined in either the test standard or in code text. The standard shall not state that its provisions shall govern whenever the referenced standard is in conflict with the requirements of the referencing code. The preface to the standard shall announce that the standard is promulgated according to the consensus procedure.

**303.2 Expressing Maximum and Minimum Limits.** Maximum and minimum limits shall be expressed with the following type of phraseology.
(1) Shall not exceed 6 feet (1829 mm).
(2) Shall have a clearance of not less than 4 feet (1219 mm).
(3) Shall be supported at intervals not exceeding 3 feet (914 mm).
(4) Shall be located not more than 5 feet (1524 mm).

**303.3 Maintenance.** Where maintenance provisions are within the scope of a document, maintenance requirements shall be located in a separate section or chapter at the end of the main text of the document, independent of requirements for a new installation.

**303.4 Product Standards.** Product standards shall be written such that the product is evaluated and tested for compliance with minimal or no judgmental decisions.

**303.5 Specification of Material.** Specification of a particular material, method, product or proprietary agency shall only be permitted in accordance with IAPMO patent policy.

**303.6 When to use "When" and "Where".** When is a time relative pronoun and should be used in the following examples:
The gas detection system shall be designed to activate **when** the level of flammable gas exceeds 25 percent of the lower flammable limit (LFL). Doors remotely unlocked under emergency conditions shall not automatically relock **when** closed unless specific action is taken at the remote location to enable doors to relock. The sprinkler system shall be designed to wet completely the entire surface of any glazing affected by fire **when** actuated.

Where is a location relative pronoun and should be used in the following examples:
**Where** a floor opening is permitted between communicating floor levels of a housing unit in accordance with Section 408.5.1, plumbing chases serving vertically staked individual cells contained with the housing unit shall be permitted without a shaft enclosure. Each sleeping area in Occupancy U shall be separated from the adjacent common spaces by a smoke-tight partition **where** the travel distance from the sleeping area through the common space to the corridor exceeds 50 feet. **Where** cellulose nitrate film is utilized or stored, such rooms shall comply with NFPA 40.

### 304.0 Rules for Mandatory Documents.

**304.1 Chapters and Appendices.** All Chapters and Appendices shall be written in mandatory language except Chapter 2.

**304.2 Chapter 2.** Section 201.0 of Chapter 2 shall contain general information as to the scope of this chapter. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Webster's Collegiate Dictionary*, the latest edition, shall be the source for the ordinarily accepted meaning.

**304.2.1 Definition of Terms.** Definitions shall not be written in mandatory language.
(1) A definition shall only describe the term being defined.
(2) Definitions shall be in the format of a term followed by the definition phrase to form a single paragraph.
(3) Definitions shall not contain requirements.
(4) References to other documents or sections of a document, notes, lists, footnotes, cautions, warnings, or figures shall not be permitted in definitions.

(5) Definitions contained in the Regulations Governing Committee Projects shall be used where applicable. Modifications to official definitions appearing in the Regulations Governing Committee Projects shall be submitted to the Standards Council (see Appendix A for official definitions).
(6) Where an existing preferred definition is taken from another document, the source document shall be referenced in brackets at the end of the definition to indicate that the definition has been extracted from that document (e.g., [NFPA 54:3.3.7]).

**304.3 Referenced Standards Table.** The Referenced Standards Table shall include referenced standards and shall consist of three sections as follows:
(1) Standards for Materials, Equipment, Joints, and Connections. When more than one standard has been listed for the same material or method, the relevant portions of all such standards shall apply.
(2) References. Standards shall be referenced with the applicable code section. All reference listings in the Referenced Standards Table shall contain complete reference information (e.g., promulgator, standard number and date of publication, standard title, application, and referenced sections).
(3) Abbreviations. Abbreviations used in the Referenced Standards Table shall contain a list for the referenced promulgator and contact information located at the end of the chapter.

**304.4 Indicating References.** References shall be referred to throughout the document by only their promulgator and numerical designation (e.g., ASTM A74).

### 305.0 Writing Mandatory Requirements.

**305.1 General.** Where a sentence in a code or standard does not contain a mandatory requirement, it shall be rewritten to include a mandatory requirement as follows:
(1) The terms “shall” and “shall not” shall be used to indicate mandatory requirements.
(2) Figures and tables shall be permitted to appear in the mandatory section of a code and standard only when they are referenced using mandatory language.
(3) Use of the terms “may”, “should”, “can”, “could”, and “might”, shall not be used in a code.

**305.2 Exceptions.** Exceptions shall be permitted only where the exception represents an allowance or required an alternate procedure to a general rule when limited, specified conditions apply.

**305.2.1 Rewording.** Where the rewording of exceptions as requirements or removal of exceptions will not change the technical requirements of the document, exceptions shall be reworded as requirements or removed.

**305.2.2 Multiple Requirements.** Exceptions shall not be used in place of several multiple requirements where the intent is to divide long sentences that incorporate a single rule that applies.

**305.2.3 Use or Application.** Exceptions shall not be used where the exception covers the use or application and would more appropriately be addressed as a requirement.

**305.2.4 Basic Rule.** Exceptions shall not be used where there is a long list of exceptions indicating that the basic rule is often inapplicable.

**TABLE 305.0**
**TYPICAL MANDATORY TERMS**

| | | | |
|---|---|---|---|
| Are | Is not intended to prohibit | Must | Shall not…except |
| Is | Is not prohibited from | Shall | Shall not…unless |
| Is capable of | Is not required | Shall not be required | Will |

**305.3 Notes.** Notes shall not be used in the mandatory text sections of a document and shall be referenced as follows:
(1) Notes shall only be used in tables and figures.
(2) Table and figure notes shall not include mandatory requirements unless otherwise indicated by extracted language.
(3) Cross-references to text sections containing mandatory requirements shall be permitted in table and figure notes.
(4) In table and figure notes, cross-references to mandatory text sections shall not be written in mandatory language.

**305.4 Cross-References.** Mandatory cross-references shall be to specific mandatory requirements in other sections of the document and shall be stated in mandatory language as follows:

(1) A cross-reference shall not be made to an entire chapter unless a cross-reference to one or more sections would not be complete.

(2) A cross-reference shall be made to an entire section, where all of the cross-referenced section is applicable and relevant.

**305.5 References.** References to other documents within the mandatory text of a code or standard shall be mandatory. Recommended practices and guides shall not be referenced in the mandatory text of a document.

# CHAPTER 4 EDITORIAL STYLE

## 401.0 Editorial Style.

**401.1 General.** Editorial style shall focus on the grammatical format used throughout the document.

**401.2 Text Editorial Rules.** Style, including grammar, punctuation, and conventional presentation of text, shall conform to the recommendations of *The Chicago Manual of Style* latest edition.

**401.3 Spelling.** Spelling and definitions of general words and terms shall follow *Webster's Collegiate Dictionary,* latest edition. When a choice of spelling is given in *Webster's*, the simpler form shall be used in IAPMO documents.

**401.4 Generic Terms.** Generic terminology shall have the spellings and meanings as outlined in the IAPMO Regulations Governing Committee Projects.

**401.5 Standard Definition.** When a standard definition is needed, *Webster's* shall be utilized where the meaning is correct and accurate as used in IAPMO documents.

**401.6 Capitalization.** Capitalization shall follow conventional usage, including the capitalization of proper names.

**401.7 Titles.** Chapter and similar designations shall be capitalized.

**401.8 Figure Captions.** Figure captions shall be capitalized.

**401.9 Table Titles.** Table titles shall be capitalized; except measurements.

**401.10 Text Headings.** The first letter of each word in text headings shall be capitalized.

**401.11 Preposition or Conjunction.** In text headings, a preposition of four letters or less (with, from), article (an, the), or coordinating conjunction (and, but, of) shall be lowercase unless it is the first or last word.

**401.12 Hyphenated.** The first letter of both parts of a hyphenated word shall be capitalized.

## 402.0 Definitions.

**402.1 General.** All definitions for terms in the document shall appear in Chapter 2 and shall contain only definitions for terms used in the document.

**402.2 Defined Terms in Other Chapters.** Definitions shall be permitted to be given in other chapters, provided that the definition is relevant to the specific chapter and also appears in Chapter 2.

**402.3 Types of Entries.** All definitions within the sections of Chapter 2 shall be divided into main entries and subentries.

**402.3.1 Main Definition.** Main definition entries shall consist of either of the following:
(1) A primary noun that groups sets of subentries (e.g., *pressure*, is the main entry that groups subentries such as *static pressure and residual pressure)*
(2) Subentry definitions shall consist of terms that define specific types of main entries (e.g., *static pressure* and *residual pressure* is subentries that define types of the main entry *pressure).*

**402.3.2 Alphabetizing Entries.** All definitions shall be listed in Chapter 2 in alphabetical order as follows:
(1) Main definition entries shall be arranged alphabetically within each section.
(2) Subentry definitions within a grouping shall be arranged alphabetically under the main entry definition.

**402.3.3 Numbering Entries.** All definitions shall be numbered. Main definition entries shall be numbered consecutively by adding periods and consecutive Arabic numbers to the section number (e.g., 203.0 -A-, 204.0 -B-, 205.0 -C-).

**403.0 Units of Measure.**

**403.1 Units of Measure.** When referring to a mathematical, technical or scientific text, physical quantities such as distances, lengths, areas, volumes, pressures, and temperatures, whether whole numbers or fractions shall be written out as numerals (e.g., 60 inches, 10 pounds, 3 cubic feet, 30°F).

**403.2 Fractions.** When not a unit of precise measurement, common fractions shall be spelled out (e.g., two- thirds or one-half) and include a hyphen.

**404.0 Punctuation.**

**404.1 General.** Punctuation shall follow conventional usage as outlined in *The Chicago Manual of Style.*

**404.2 Use of Periods with Titles and Headings.** Periods shall not be used after the main title of a document, after chapter titles, or at the end of table titles.

**404.3 Use of Periods with Figure Captions and Equation Titles.** Periods shall not be used at the end of figure captions.

**404.4 Use of Periods with Section Headings.** Periods shall be used at the end of each section, subsection, and paragraph heading.

**404.5 Use of Periods with Abbreviations.** Periods shall not be used in abbreviations of units of measure.

**404.6 Use of Commas with Items in Series.** Commas shall be used for items in a series as follows:
Examples:
(1) She took a photograph of her parents, the president, and the vice-president.
(2) You can turn left at the second fountain, or turn right at the statue of Venus, or just ask a local person how to get there.

If the elements in a series are short and joined by a conjunction (e.g., and, or, nor, but, yet, for, so) a comma is not necessary (e.g., Is it by Snodgrass or Shapiro or Brooks?).
If the elements in a series include an ampersand a comma is not needed (e.g., Pipe, tubing & fittings).
If the series involves internal punctuation a semicolon shall be used (e.g., The membership of the international commission was as follows: France, 4; Germany, 5; Great Britain, 1; United States, 7.).

**404.7 Document Structure Rules.** Lists shall be within the body of an existing paragraph and shall be preceded by introductory text and a colon.

**404.7.1 List Placement.** Lists shall not be within the middle of a sentence.

**404.7.2 Style of Lists.** The structure of all items within a list shall be parallel — that is, the items shall be all single words, all phrases, or all full sentences (unless an extraction dictates).

**404.7.3 Single Words and Phrases.** In lists consisting of single words and phrases, the introductory text shall include mandatory language that establishes the requirement for the paragraph. Periods shall not be used at the end of single words or phrases unless, due to an extraction, a complete sentence is present within the list, therefore, requiring periods at the end of all list items.

**404.7.4 Introductory Text.** In sentence-style lists, the introductory text shall contain mandatory language if each item is not stated as a requirement.

**404.7.5 Sentence Structure.** In sentence-style lists, each item shall consist of only one sentence.

**404.8 Types of Lists.** Main lists shall be a grouping of listed items within a numbered or lettered section.

**404.8.1 Numbering.** The hierarchy for numbering and lettering listed items shall be as follows:
402.1 Main list item
(1) Sub-list item
(a) Insert lower case lettering as a sub-list when there is a list within a list.

**404.8.2 Unnumbered Lists.** Unnumbered lists, in which the items have no means for being cross-referenced, shall not be used.

**404.9 Figures.** Figures shall be numbered and cross-referenced within the appropriate section or subsection.

**404.9.1 Numbering.** Numbering shall correspond to the section, subsection, or paragraph in which the figure is cross-referenced (e.g., Figure 403.1).

**404.10 Tables.** Tables shall be numbered and cross-referenced within the appropriate section, subsection, or paragraph of text.

**404.10.1 Numbering.** Numbering shall correspond to the section, subsection, or paragraph in which the table is cross-referenced (e.g., Table 412.0). Where multiple tables appear in the same section, they shall also be numbered (e.g., Table 412.1(1), Table 412.1(2), Table 412.1(3)).

**404.11 Equations.** Equations shall be numbered only when necessary for cross-referencing purposes.

**404.11.1 Numbering.** Equation numbers shall correspond to the section, subsection, or paragraph in which the equation is cross-referenced, (e.g., 507.2.2) as follows:
(1) If two or more equations appear in the same section, they shall also be numbered, e.g., 507.2.2(1) and 507.2.2(2).
(2) Equation numbers shall be in parentheses and shall appear to the right of the equation.

### 405.0 Material from Other Organizations.

**405.1 General.** To use material from other organizations in the text of an IAPMO document, IAPMO shall have written permission of the organization from which the material was obtained.

**405.2 Staff Responsibility.** The IAPMO staff liaison shall be responsible for ensuring written permission is obtained for use of materials from other organizations.

**405.3 Credit Line.** A credit line within the text and a reference citation in the appropriate reference chapter or annex shall be provided to acknowledge the copyright holder of the material (e.g., ASHRAE 34: TABLE 1).

**405.4 Explanatory Information.** Explanatory statements that do not contain requirements shall not be used in the document.

### 406.0 Cross-References.

**406.1 Cross-References.** Cross-references to other sections, tables or figures within the document shall be specific and shall be placed where most relevant in the paragraph.

**406.2 Cross-References to Chapters and Sections.** A cross-reference to a chapter or section shall include the word Chapter or Section in the text.

**406.3 Cross-References to Standards.** A cross-reference to a standard shall include the standard promulgator and number (e.g., ASTM D 2665).

**406.4 Cross-References to Figures and Tables.** Cross-references to figures and tables shall be made using the applicable number preceded by the word Figure or Table.

**406.4.1 Cross-Reference to Multiple Tables/Figures/Sections/Chapters/Appendices.** When cross-reference is made to two or more figures or tables, the word Figure or Table shall be repeated before each number (e.g., Table 402.1 and Table 602.1).

**406.4.2 Cross-Reference to a Range of Tables/Figures.** When cross-reference is made to a range of figures or tables, the word Figure or Table shall be repeated before each number in the range (e.g., Figure 402.2 through Figure 402.5).

**406.5 References to Publications.** The following rules shall apply to references to publications in the text of a document:
(1) References to publications in the text shall be for the purpose of supplementing requirements.
(2) In codes, only mandatory references shall appear in the text of the document.
(3) Bibliographical and informative references shall not be included in the text of a document but only in explanatory material, in a table or footnote.

**406.6 Reference Lists.** The specific identification of referenced publications and their source shall be included in the list of referenced standards given in the Referenced Standards Table.

**406.6.1 Referenced Edition.** The current, approved edition of the referenced standard shall be included in the Referenced Standards Table. The user shall list the references separately to facilitate updating to the latest edition.

**406.6.2 Updates.** Updates of references to standards shall be completed by the appropriate Technical Committee and shall be processed by the Regulations Governing Committee Projects.

**406.7 Identification of Figures.** Identification of figures in the main text of the document shall portray mandatory requirements. All figures shall be referenced in the text, and the figure number shall be the same number as the section, subsection, or paragraph where it is referenced in the text.

**406.7.1 Figure Position in Text.** The caption of the figure shall appear below the figure. When used in the text, a figure shall be placed as near to its first reference in the text.

**406.7.2 Labeling.** All significant elements in a figure shall be labeled with terminology that matches the text discussion.

**406.7.3 Dimensions.** All dimensions shall be indicated with SI units. Units of measure used in figure labels shall be abbreviated.

**406.8 Identification for Tables.** A number and a title shall identify each table. All tables shall be referenced in the text, and the table number shall be the same number as the section, subsection, or paragraph where it is referenced in the text.

**406.8.1 Multiple References for Tables.** If more than one table is related to a single section, subsection, or paragraph, references shall be made to the main section.

**406.8.2 Table Titles.** The table title shall be all caps. The reference to table shall be in uppercase letters (e.g., TABLE 403.3).

**406.9 Column Headings.** The first letter of each word in a column heading shall be capitalized. The first letter of every word in column sub-headings shall be capitalized.

**406.10 Units of Measure.** Units of measure shall always be given in the column headings or table footnote.

**406.10.1 Placement.** When the same unit of measure is used throughout a column, the unit of measure shall be given in the column heading instead of the column itself. When a column contains more than one unit of measure, then the units of measure shall be used in the column and not in the column heading.

**406.10.2 Abbreviated Units.** Units of measure shall be abbreviated in tables. SI conversion measurement to metric shall be used at the bottom of the table.

**406.10.3 Vacant Cells.** A dash (—) shall be used to indicate a vacant cell.

**406.10.4 Numerical Columns.** The tabular material shall be centered in each column and numbers shall be aligned on the decimal point, and zeroes shall be placed before the decimal point in numbers less than one. Decimal indications shall be used in tabular work unless fractions are used.

**406.11 Placement of Table.** Tables shall fit vertically on a page. When a table carries over for more than one page, the heading shall read “continued” on successive pages.

**406.12 Notes.** Notes shall only be permitted as table notes and shall appear directly beneath the table after the SI notation.

**406.12.1 Identification.** All notes shall be indicated using the word “Note(s)” in (bold) followed by consecutively numbered text notes. Font size 8-point, Times New Roman.

**406.12.2 Placement.** All notes shall be superscript numbers used in sequential order.

**406.12.3 Table Notes.** Table notes shall be identified as follows:
(1) If there is one note, an asterisk shall be used.
(2) If there are two or more notes, superscript numbers shall be used in sequential order.

**406.13 Formulas and Equations.** Punctuation shall be inserted following equations as grammatically necessary for sentence flow.

**406.13.1 Explanation of Terms.** Explanation of terms shall appear under the formula or equation introduced by the word "*Where.*"

**406.13.2 Table of Symbols and Letters.** The explanatory material shall be permitted to be omitted if symbols and letters are explained in a table of symbols elsewhere in the document.

**406.13.3 Fractions.** Fractions shall be the single case (e.g., ⅞ rather than 7/8).

**406.13.4 Formulas, Letter Symbols and Variables.** Formulas appear on a separate line, centered in the column.

**406.13.4 Italics.** Formulas, letter symbols, and variables shall be printed in italics.

**406.13.5 Metric Equivalent.** Where applicable, a formula shall be followed immediately by its metric equivalent, preceded by the phrase, "For SI units:"

**406.13.6 Layout.** Following the formula (and the metric equivalent, if applicable), the word "Where" shall appear, followed by definitions of the variable.

**406.13.7 Listing of Variables.** Variables shall be listed in alphabetical order, and lowercase letters shall be listed after their respective uppercase letters. Greek and other characters shall be listed last.

**406.13.8 Multiple Formulas.** Where more than one formula appears per section; it shall be numbered, and number shall be in Roman type, flush right and appear on the line above the formula.

**406.14 Degree Symbol.** The degree symbol shall be used when referring to temperature; spell out "degree" when referring to angle dimensions.

**406.14.1 Temperature.** The degree symbol shall be used to express temperature with the appropriate letter symbol (e.g., 39°C is the acceptable abbreviation for 39 degrees Celsius).

**406.14.2 Not Required.** The degree symbol shall not be required for absolute temperature scale of Kelvin (K).

**406.15 Percent Symbol.** The percent symbol shall be spelled out.

# CHAPTER 5 UNITS OF MEASUREMENT

## 501.0 Units of Measurement.

**501.1 System Preference.** The system of measurement used in IAPMO codes shall conform to the following conventions and shall be used consistently throughout the document:

(1) All measurements shall be presented in both English units and metric (SI) units.
(2) Measurements shall be presented in English and followed in parentheses by the equivalent metric (SI) value.
(3) In the text, the metric (SI) unit equivalent shall be placed in parentheses immediately following the English unit. In tables and figures, the (SI) unit equivalent shall appear immediately following the table or figure. Where an English measurement is part of a compound adjective, the metric equivalent appears after the compound (e.g., 6 inch (152 mm) diameter circle).
(4) Where a metric dimension has five or more digits, space shall appear after every three digits (e.g., 10 354 mm).

**501.2 Extracted Material.** Where the extracted material contains values expressed in both systems of measurement, the units shall be arranged in accordance with Section 501.1.
Where the extracted material contains values expressed only in one system of measurement, the measurement shall conform to Section 501.1.

**501.3 Basis of Measurement.** The intended accuracy and precision shall reflect what is intended and practical for application and enforcement.

**501.4 Conversion Calculations.** For SI unit conversions shall be exact and shall not be rounded to the nearest whole number (see Table A 9.0 for exact conversions). Conversion calculations that are not SI units shall use rounded values of the conversion factor and measurement value (see A 7.0 for inches to millimeters). For all other conversions shall be in accordance with A 9.3

**501.5 Reference Publication.** As a supplement to the criteria contained within Chapter 5 and for items not addressed herein, the reference document on which all SI conversions are to be based shall be NIST Special Publication 811, Guide for the Use of the International System of Units (SI), 2008.

# APPENDIX A EXPLANATORY NOTES

**A 1.0 General.** This appendix provides an overview and examples of various topics and references for technical writing, layout and editing.

**A 2.0 Definitions.** The following definitions shall be used in the body of the text and shall be consistent with the intent of these meanings. Definitions shall not be altered unless approved by the Standards Council. The following definitions are from the Regulations Governing Committee Projects as follows:

**Approved.** Acceptable to the authority having jurisdiction.

**Authority Having Jurisdiction (AHJ).** The organization, office, or individual responsible for approving equipment, materials, an installation, or procedure.
**Note:** The phrase "authority having jurisdiction," or its acronym AHJ, is used in IAPMO documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a plumbing official; mechanical official; labor department; or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

**Code.** A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.
**Note:** The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use, and form of adoption, and whether it contains substantial enforcement and administrative provisions.

**Consensus.** Consensus has been achieved when, in the judgment of the Standards Council, substantial agreement has been reached by materially affected interest categories. Substantial agreement means much more than a simple majority but not necessarily unanimity. Consensus requires that all views and objections be considered and that a concerted effort is made toward their resolution. The Standards Council bases its judgment as to when a consensus has been achieved on the entire record before the Council.

**Guide.** A document that is advisory or informative in nature and that contains only nonmandatory provisions. A guide may contain mandatory statements such as when a guide can be used, but the document as a whole is not suitable for adoption into law.

**Labeled.** Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

**Listed.** Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.
**Note:** The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

**Recommended Practice.** A document similar in content and structure to a code or standard but that contains only nonmandatory provisions using the word "should" to indicate recommendations in the body of the text.

**Shall.** Indicates a mandatory requirement.

**Should.** Indicates a recommendation or that which is advised but not required.

**Standard.** A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or adoption into law. Nonmandatory provisions shall be located in an appendix, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

**A 3.0 Technical Style.** Technical Style is how the technical requirements are presented to the user. Chapter 3 addresses how the technical committee shall write the technical requirements of the document. Technical style is separate from editorial style, in which the technical wording is modified to ensure that the presentation is grammatically accurate and understandable. The technical committee responsibility lies with reviewing all wording within the document to ensure the requirements, and its own wording is not vague or unenforceable. Where terms are used that are vague or unenforceable, the requirements are often misapplied or misinterpreted. Table A 3.0 is a list of phrases that are nonmandatory and changed to reflect mandatory requirements.

**TABLE A 3.0**
**TYPICAL MANDATORY TERMS AND PHRASES**

| VAGUE TERMS/PHRASES | TYPICAL PHRASES TO BE USED |
|---|---|
| May | Shall or shall be permitted* |
| Not be less | Be not less |
| Not less than 4 inches | Not less than 4 inches in diameter (when intent is diameter of pipe) |
| Shall be a minimum of 4 pounds | Weigh not less than 4 pounds |
| All tubs | Noun/tubs |
| More than | Not more than |
| When | Where |
| As required by | In accordance with |
| Higher than | Exceeding |
| Equipment | Appliances |
| Conformance | Accordance |
| Of | More than |
| May | Is permitted to or shall be permitted* |
| With any | By |
| That may | Allowed |
| From | To |
| No more than… | Shall be not more than…. |
| Safe, Safety | When this term appears, it shall be either be replaced with a detailed outline of what constitutes "safe" or "safety" or be followed by detailed information. |
| Nationally recognized design | Where one of these phrases is used, it shall either be replaced with a reference to a specific document or follow the phrase with a detailed list of the elements regulated by the design method. |
| Accepted method | When this phrase is used it shall be followed by a detailed outline that provides the user of the document the elements for determining what must be present if it would be approved (by an approved design method that takes into account the …list of specific details that shall be accounted for in the design). |

*This phrase is typically unnecessary. Unless a specific condition, method or item is specifically "prohibited" within a document, it is always "permitted." When the phrase is used to indicate a conditional provision, e.g., "shall be permitted… provided," such phrase shall be written to indicated when a provision is not to be allowed rather than when it is permitted.

**A 4.0 Editorial style.** The following is a compilation of rules that shall be used to assist in developing code language regarding editorial style.

**A 4.1 Use of Simple Words.** Avoid using more words than are necessary to express a requirement. For example instead of using the phrase "large number of" use the word "many" or "is provided with" use instead "has."

**A 4.2 Redundancy.** Avoid redundancy when emphasizing a point.

**A 4.3 Careful Use of Adjectives and Adverbs.** Adjective and adverbs clarify the text. Avoid unnecessary modifiers as they obscure rather than clarify the meaning. Qualifying words that do not lend themselves to objective measurement lead to ambiguity. For example, in the phrase "suitable method of test" what is meant by or defined as suitable.
**Note:** Ensure that all modifiers have precise definitions.

**A 4.4 Synonyms.** Synonyms of technical terms shall be used with caution. An item shall not be called a "drainage fixture unit" one time and "fixture units" a second time. Ambiguity shall be avoided by expressing the term the same way each time that it is used.
**Note:** Assure, ensure and insure are listed as synonyms in dictionaries. The use of "ensure" shall be used when the meaning is to "make sure" is intended use. Insure shall be used when financial matters are described. For consistency, assure shall be avoided except when using in the context of "quality assurance."

**A 4.5 Hyphenated Words.** The rule is to check the dictionary first and then apply the following rules to add a hyphen:
(1) Two or more adjectives before a noun that act as one idea (e.g., this is a low-budget job). The words low job and a budget are linked to a single concept.
(2) Where words have become linked to express one idea (fine-tune).
(3) Where written as words, fractions consisting of two words (one-fourth or two-thirds)
(4) Hyphenate words prefixed by ex or self or all [e.g., all-inclusive, cross-reference (adj)]

The following rules shall apply where a hyphen shall not be added as follows:
(1) Chemical terms;
(2) Adverb ending in ly;
(3) Using a letter or numeral as the second element (e.g., Class A priority);
(4) Words prefixed by non, un, in, anti, hyper, pre, micro and inter, over and under (e.g., semiannual, interconnected, bimonthly, biannual and decompress).

**A 4.6 Number and Numeral Writing.** The following rules shall apply when to spell out numbers and when to use numerals.
(1) Never begin a sentence with a numeral.
(2) When using a set of numbers, use numerals.
(3) Decimal fractions and percentages shall be expressed in numerals, not in words.
(4) Unit of Measurement or time shall be expressed as numerals (e.g., 3 cubic feet, 45 pounds per square inch, 6.5 meters, 240 volts).
(5) When not referring to a unit of measurement or time, single digit numbers one through nine shall be spelled out. Numbers 10 and larger shall be written as numerals.
(6) When writing decimals, do not use the word point. For example, to express 10.7 would be ten and seven-tenths.
(7) When numbers are adjacent, spell out one number and use numerals for the other (e.g., 8 six-foot high).
(8) Percentages shall be spelled out and only use the symbol (%) in headlines, table, and charts.
(9) When referring to a unit of time all numbers shall be written out, including numbers between 1 and 10 (e.g., 1-hour fire-resistance rating).
(10) When writing fractions as words (not measurements) insert a hyphen (e.g., one-half).

**A 4.7 Careful Use of Problem Words.** Use of words such as shall is always preferred to must because it indicates that a statement is a requirement as mandatory and leaves no decision to be made by the reader. The use of and/or when stating requirements shall be avoided because it leaves the decision to the reader as to what is required. The use of these words shall be reworded to clarify intent. For example, avoid using the following phrase, "elbows and/or tees shall" use instead, "elbows, tees or both shall" or if the intent is to require both then use "elbows and tees shall." Where the intent is to require one or the other term, then use "elbow or tee shall." Note "when" a time relative pronoun is and "where" a relative location pronoun is.

**A 5.0 Technical Layout for Publications.** Technical layout provides for the publication of documents based on style to achieve continuity throughout the code.

**A 5.1 Table of Contents.** Table of contents shall be set in two columns. Chapter designation and titles shall be all caps and in Helvetica Bold font size 9. The section designations shall be in upper/lower case in plain type; Helvetica font size 9. Leader dots and page numbers shall be boldface for chapter title and prepositions shall be lowercase. The layout of the Table of Contents shall be as follows:

**A 5.2 Running Heads and Folios.** The layout of running heads and folios shall be as follows:

(A) Top of Page-Running Heads
  (1) Chapter titles inclusive on that page set even with the outside margin.
  (2) Running heads in the appendices shall read **APPENDIX A**.
  (3) Running heads in the index shall read **INDEX.**
  (4) Running heads shall be omitted in the front, table of contents, the first page of a chapter and on blank pages.
  (5) Shall be set at .56 of an inch from the top of the page.

(B) Bottom of Page-Folios
  (1) Page number shall be flush with the outside margin.
  (2) Book title and year shall be all caps, flush with the inside margin.
  (3) Page number and book title shall appear on every page, including blank pages.
  (4) The page numbers for the front and Table of Contents shall be lowercase roman numerals.
  (5) Page numbers shall be 8 point Helvetica Bold flush with the outside margin.
  (6) Book title and year shall be in all caps in 8 point Helvetica Bold, flush with the inside margin.
  (7) Both shall be set at 0.33 of an inch from the bottom of the page.

**A 5.3 Body of Code.** The layout of the body of the code shall be as follows:

(A) IAPMO codes are 8 ½ by 11 inches. Column width shall be 3.35 inches, with a 0.3 of an inch gutter. The margins shall be top 1.08 of an inch; bottom 0.67 of an inch; inner 1 inch and outer 0.5 of an inch.
  (1) Text shall be 10 point Times New Roman, set in two columns. ALL text shall be set with 11.5 point, should not exceed 12 point and no less than 11 point leading.
  (2) In the table of contents, the chapter designation and titles shall be all caps and 9 point Helvetica Bold; the sections are 9 point Times New Roman.
  (3) Formulas shall be 10 point Times New Roman.

(B) Chapter Headings
  (1) All chapters (including appendix chapters) shall begin on a right-hand (odd-numbered) page.
  (2) The chapter designation (e.g., **CHAPTER 1**) shall be 16-point Helvetica Bold, all caps and centered on the page. The chapter title shall be 12-point Helvetica Bold, all caps, centered on the page and directly below the chapter designation. Set text box alignment to the top, bottom runaround to 18 point and top to 1 point.

(C) Sections
  (1) Each section shall have a number and a title (that describes the content of the section).
  (2) The section designation (e.g., **301.0 Materials-Standards and Alternates**) shall be 10 point Helvetica Bold, first letter caps and flush with the left margin. Between section title and text is a 0.04 of an inch.
  (3) The subsection designation and title shall be flush with the left margin with no indentation. The subsection number and title shall be in boldface type. Only the first letter of each word shall be uppercase. Text immediately follows the subsection title.
  (4) All text shall be full justified.
  (5) If a subsection contains more than one paragraph, the first line of the following paragraphs shall be indented 0.25 of an inch.
  (6) All subordinate sections shall be block indented 0.25 of an inch.
  (7) Sections shall be designed by Arabic numbers in sequence (e.g., sections in Chapter 5 shall be numbered 501.0, 502.0, 503.0, 504.0, 505.0, 505.0, 506.0, 507.0 etc.). Subsections shall be numbered consecutively by adding a period and a number to the section number (e.g., subsections in Section 507.0 shall be numbered 507.1, 507.2, 507.3, 507.4, 507.5, 507.6, etc.). Paragraphs shall be numbered by adding a period and consecutive numbers to the subsection number 507.1 (e.g., subsections in Section 507.1 shall be numbered 507.1.1, 507.1.2, 507.1.3, 507.1.4, etc.). Subparagraphs shall be numbered by adding a period and consecutive numbers to the paragraph number (e.g., 507.1.1.1, 507.1.1.2, 507.1.1.3, 507.1.1.4, etc). The total number of digits, including the chapter number designator, shall not exceed six digits [e.g., 507.1.1.1].

(D) End of Chapter
  (1) At the end of the chapter, the text shall fill the first column and then flow to the second column (columns are not aligned).

Example:
**402.1 Water-Conserving Fixtures and Fittings.**
**402.2 Flush Volumes.**
**402.3 Water Closets.**
**402.4 Urinals.**
**402.3.1 Nonwater Urinals.**

**404.1 Strainers and Connections.**
**404.2 Strainers.**
**404.3 Connections.**
**404.3.1 Fixture Tailpiece.**
**404.3.2 Directional Fittings.**
**404.2.2.1 Waste and Water Connections.**

**A 5.4 Definitions.** The layout for definitions shall be as follows:
(1) Definitions shall be flush left with no indentation. The primary definition will be flushed to the left, no indention. Subentry definition will be indented 0.25 of an inch.
(2) The words to be defined shall be in boldface type. Only the first letter of each word shall be uppercase. Text shall immediately follow the definition.
(3) Each definition shall be placed under the corresponding letter of the alphabet. Each letter of the alphabet shall be bold and centered with its corresponding section number.

Example:
**220.0 —R—**
**Receptor.**
**Regulating Equipment.**

**221.0 —S—**
**Sand Interceptor.**
**SDR.**

**222.0 —T—**
**Trap Seal.**
**Crown Weir.**
**Top Dip.**

**A 5.5 Exceptions.** The layout for exceptions shall be as follows:
(A) Exceptions shall be aligned with the section to which it refers and in the same point size as the regular text.
(B) The word "Exception" shall be in boldface type, followed by a colon. Only the first letter shall be uppercase.
(C) Singular exceptions shall be run on the same line. For multiple or numbered exceptions, the first exception starts on a separate line with a hanging indent.
(D) Not less than two lines of an exception shall appear on the same page as the section to which it references.

Example:
**412.3 Separate Facilities.** Separate facilities shall be provided for each sex.
**Exceptions:**
(1) Residential installations.
(2) In occupancies serving 10 or fewer people.
(3) In business and mercantile occupancies.

**A 5.6 Tables.** The layout for a table shall be as follows:
(A) Designation and Title (including extraction references):
(1) The table designation and title shall be all caps in 8 point Helvetica Bold, centered above the table. The table title shall be directly below the designation. The space between the title and table shall be 0.08 of an inch. All borders should surround the table by a hairline thickness.
(2) The table designation shall match the section that references the table.
(3) There shall be no units of measurement in table titles as all units are part of the appropriate column heading.
(B) Location
(1) Tables shall appear directly following the section that references the table (e.g., depending on the layout of the page).
(2) Where a table does not fit in a single column, the table shall be displayed in both columns.

(C) Breaking Tables
  (1) Tables shall not be broken unless the entire table does not fit on a single page.
  (2) If a table breaks, (continued) shall appear centered underneath the table at the bottom of the page, font shall be all lowercase and the table designation, title and column headings shall be reprinted at the top of the next page, with (continued) on the same line immediately following the table designation.

(E) Column Headings
  (1) First level headings shall be in all caps and 7 point Helvetica bold.
  (2) Second level headings, words shall be capped and 7 point Helvetica bold.
  (3) Units of measurement shall appear in parentheses, all lowercase.
  (4) Column headings shall be centered horizontally and vertically.

(F) Text in Columns and Rows
  (1) Horizontal lines shall be used to divide each row of text.
  (2) For entries in a table, only the first letter of the first word in uppercase.
  (3) Text in the left-hand column shall be flush left for major categories; subcategories shall be indented one space. Where entries in the column are numbers, the numbers shall be centered horizontally and vertically in the cell.
  (4) Text in all other cells shall be centered horizontally and vertically. Where a cell contains only a reference to a footnote, the reference shall be preceded by "Note."
  (5) A dash shall appear when there is no text in a cell.
  (6) Text in the table shall be 9 point Times New Roman.
  (7) Rule weight is 0.02 of an inch. Space between rules and text shall be determined by the leading.

(G) Metrics
  (1) Metric equivalents or conversion factors shall not appear in the body of the table. Instead, conversion factors for all units of measurement used in a table shall immediately follow the body of the table, preceding footnotes, in 8 point Times New Roman. The space between the table and the metric text shall be 0.03 of an inch.
  (2) Conversion factors shall be preceded by the phrase "For SI units: 1 inch = 25.4 mm." Conversions shall be in a standard order of sequence (smaller unit of measure first; e.g., 1 inch = 25.4 mm, 1 foot = 304.8 mm). Conversions shall be exact and shall not be rounded to the nearest whole number (see Table A for exact conversions). Commas shall separate the conversions with a period at the end of the line. A conversion shall never split over two lines. All English units shall be spelled out.
  (3) For SI units, they shall appear immediately following a table.

(H) Notes
  (1) Superscript numbers shall be used instead of letters for notes.
  (2) The notes shall appear following the table, aligned with the table width, and following the conversion factor, if applicable.
  (3) If there are two or more notes, superscript numbers (font size 10 point) shall be used in sequential order (e.g., $^{1, 2, 3,4etc}$).
  (4) The text of the notes shall be 8 point Times New Roman and employs a hanging indent; left indent 0.1 and first line indent -0.1. The space between the table and the notes shall be 0.03 of an inch.

Example:

**TABLE 603.2.1**
**MINIMUM AIR GAPS FOR WATER DISTRIBUTION[4]**

| FIXTURES | WHEN NOT AFFECTED BY SIDEWALLS[1] (inches) | WHEN AFFECTED BY SIDEWALLS[2] (inches) |
|---|---|---|
| Effective openings[3] not greater than ½ of an inch in diameter | 1 | 1½ |
| Effective openings[3] not greater than ¾ of an inch in diameter | 1½ | 2¼ |
| Effective openings[3] not greater than 1 inch in diameter | 2 | 3 |
| Effective openings[3] greater than 1 inch in diameter | Two times diameter of effective opening | Three times diameter of effective opening |

For SI units: 1 inch = 25.4 mm

Notes:

[1] Sidewalls, ribs, or similar obstructions do not affect airgaps where spaced from the inside edge of the spout opening a distance exceeding three times the diameter of the effective opening for a single wall, or a distance exceeding four times the effective opening for two intersecting walls.

[2] Vertical walls, ribs, or similar obstructions extending from the water surface to or above the horizontal plane of the spout opening other than specified in Footnote 1 above. The effect of three or more such vertical walls or ribs has not been determined. In such cases, the airgap shall be measured from the top of the wall.

[3] The effective opening shall be the minimum cross-sectional area at the seat of the control valve or the supply pipe or tubing that feeds the device or outlet. Where two or more lines supply one outlet, the effective opening shall be the sum of the cross-sectional areas of the individual supply lines or the area of the single outlet, whichever is smaller.

[4] Airgaps less than 1 inch (25.4 mm) shall be approved as a permanent part of a listed assembly that has been tested under actual backflow conditions with vacuums of 0 to 25 inches of mercury (85 kPa).

**A 5.7 Figures.** The layout for figures shall be as follows:

(A) Designation and Title
  (1) Figure designations shall be centered on the page in all caps in 8 point Helvetica Bold and appear directly below the figure. The designation shall match the section number that references the figure.
  (2) The figure title shall appear directly below the designation in all caps in 8 point Helvetica Bold. Extraction reference, where applicable, shall appear directly below the figure title.
  (3) Figure designations and titles shall not include metric equivalents. Applicable metric conversion factors shall appear below the figure, flush left on the page, preceded by the phrase “For SI units:”

(B) Location and Appearance
  (1) A figure shall appear as close as possible to the section that references the figure. A figure shall not be broken over two pages.
  (2) There shall be no boxes or lines enclosing figure.

**A 5.8 Equations.** The layout for equations shall be as follows:

(A) Location and Style
  (1) Equations shall be centered on the page in all caps and appear directly above the equation.
  (2) All variables in an equation shall be in italics, except for greek characters and they shall not be in italics.
  (3) Where applicable, an equation shall be followed immediately by its metric equivalent, preceded by the phrase, “For SI units.”

(B) Notations
  (1) Following the equation and the metric equivalent, (if applicable), the word “Where:” shall appear, followed by the definitions of the variables.
  (2) Variables shall be listed in alphabetical order.
  (3) Lowercase letters shall be listed after their respective uppercase letters.
  (4) Greek characters shall be listed last.

(C) Numbering
  (1) If more than one equation appears per section, it shall match the section number that references the equation. For example, if equations are to be referenced in Chapter 4, equation numbers shall be “Equation 401.1, Equation 402.1, etc.”
  (2) Equation number shall be 10 point times new roman font, flush right and appear on the same line of the equation.

Example:

$V_{bz} = R_p P_z + R_a A_z$ (Equation 401.1)

Where:

$A_z$ = zone floor area: the net occupiable floor area of the zone ft.$^2$ (m$^2$).

$P_z$ = zone population: The largest number of people expected to occupy the zone during typical usage. If the number of people expected to occupy the zone fluctuates, $P_z$ shall be permitted to be estimated based on averaging approaches described in Section 403.5.2. If $P_z$ cannot be accurately predicted during design, it shall be estimated based on the zone floor area and the default occupant density listed in Table 4-1.

$R_a$ = outdoor airflow rate required per unit area as determined from Table 4-1.

$R_p$ = outdoor airflow rate required per person as determined from Table 4-1.

$V_{bz}$ = breathing zone outdoor airflow

**A 5.9 Slope.** Slope shall be expressed regarding units vertical in units horizontal. For example, a slope shall be expressed as "¼ inch per foot (20.8 mm/m) slope."

**A 5.10 Abbreviations and acronyms.** The layout for abbreviations and acronyms shall be as follows:

(1) Sentences shall never begin with an abbreviation. Spell out the abbreviation or rewrite the sentence.
(2) Abbreviations and acronyms in the text shall be spelled out on the first usage within a chapter or appendix, with the abbreviation or acronym immediately following in parentheses [e.g., British thermal units (Btu), Drainage fixture units within a chapter or appendix (dfu) and Water supply fixture units (wsfu)].
(3) The abbreviation shall be permitted to be used in all other instances (except at the beginning of the sentence).
(4) Abbreviations shall be permitted to be used in tables and figures to converse space.
(5) All metric dimensions shall be acceptable without spelling out the word.

**A 5.11 Symbols.** The layout for symbols shall be as follows:

(1) Use the degree symbol, °, when referring to temperature; spell out "degree" when referring to an angle.
(2) The percent symbol % shall only be used in table or figures. Always spell out "percent" in the text.
(3) Spell out "by" rather than using this symbol "x".

**A 5.12 Appendices.** The layout for appendices shall be as follows:

(1) Appendices shall employ a letter designation (APPENDIX L)
(2) Section headings in appendices shall begin with the letter designation of that appendix (e.g., L 3.0 Water Heat Exchangers).

**A 5.13 Index.** The layout for the index shall be as follows:

(1) Index shall be formatted with two columns.
(2) Primary entry for alphabet listing shall be in all caps, boldface type centered in column (**-A-, -B-, -C-**)
(3) Primary Section shall be capitalized, Helvetica 9 point boldface type; remaining subsections first letter of title shall be capitalized, Helvetica 9 point type.
(4) Where there are no entries in that particular letter of the alphabet, under the alphabet letter "No definitions" is inserted into the index.
(5) Where an index entry references both a section and a table, the section references appear first then table entries.

**A 6.0 Typesetting Styles.** Typesetting Style provides for the correct style, the size of type and the desired arrangement on the page in preparation for printing.

**A 7.0 Metric Conversion Recommendations (not for SI units) as follows:**

(1) Dimensions given in "inches" are to be converted to "millimeters".
(2) Under $^1/_{16}$ (1.6 mm) inch round to 2 decimal places to the right.

0.025 = 0.64 mm
0.276 = 0.70 mm
0.040 = 1.02 mm

(3) Greater than $^1/_{16}$ inch but equal to or less than 1 inch round to 1 decimal place to the right.

$^1/_{16}$ = 1.6 mm
$^1/_8$ = 3.2 mm
¼ = 6.4 mm
$^3/_8$ = 9.5 mm
$^7/_{16}$ = 11.1 mm

| | | |
|---|---|---|
| ½ | = | 12.7 mm |
| 5/8 | = | 15.9 mm |
| ¾ | = | 19.1 mm |
| 1 inch | = | 25.4 mm |

(4) Greater than 1 inch round to the nearest whole number

| | | |
|---|---|---|
| 1 ¼ | = | 32 mm |
| 1 ½ | = | 38 mm |
| 1 ¾ | = | 44 mm |
| 2 | = | 51 mm |
| 2 ½ | = | 64 mm |
| 3 | = | 76 mm |
| 3 ½ | = | 89 mm |
| 4 | = | 102 mm |
| 5 | = | 127 mm |
| 6 | = | 152 mm |
| 7 | = | 178 mm |
| 8 | = | 203 mm |
| 9 | = | 229 mm |
| 10 | = | 254 mm |
| 11 | = | 279 mm |
| 12 | = | 305 mm |
| 15 | = | 381 mm |
| 18 | = | 457 mm |
| 22 | = | 559 mm |
| 24 | = | 610 mm |
| 30 | = | 762 mm |
| 31 ½ | = | 800 mm |
| 32 | = | 813 mm |
| 36 | = | 914 mm |
| 42 | = | 1067 mm |
| 48 | = | 1219 mm |

(5) Dimensions given in “feet” are to be converted to:

(a) Millimeters when conversion is 5 or less decimal places (e.g., 100 feet = 30 480 mm)

(b) Meters when conversion is 6 or more decimal places (e.g., 500 feet = 152 400 to appear as 152 m)

(c) Be rounded to the nearest whole number:

| | | |
|---|---|---|
| 1 foot | = | 305 mm |
| 2 feet | = | 610 mm |
| 3 feet | = | 914 mm |
| 4 feet | = | 1219 mm |
| 5 feet | = | 1524 mm |
| 6 feet | = | 1829 mm |
| 7 feet | = | 2134 mm |
| 8 feet | = | 2438 mm |
| 9 feet | = | 2743 mm |
| 10 feet | = | 3048 mm |
| 12 feet | = | 3658 mm |
| 15 feet | = | 4572 mm |
| 18 feet | = | 5486 mm |
| 20 feet | = | 6096 mm |
| 22 feet | = | 6706 mm |
| 25 feet | = | 7620 mm |
| 30 feet | = | 9144 mm |
| 40 feet | = | 12 192 mm |
| 50 feet | = | 15 240 mm |
| 80 feet | = | 23 384 mm |
| 100 feet | = | 30 480 mm |
| 400 feet | = | 121.9 m |
| 1000 feet | = | 305 m |

**A 8.0 SI Units.** The SI is based on seven defined "base units" that quantify seven based quantities that by convention are regarded as dimensionally independent. It is a matter of choice how many and which quantities are considered to be based quantities.

**A 8.1 Mass, Force, and Weight.** The SI unit for mass is restricted to the kilogram and the SI unit for force is the newton. For most of the time, weight means mass. Therefore, the term "weight" should be avoided in technical practice except when it is meaning is completely clear. When using weight, it is important to know whether mass or force is intended and to use SI units properly as described above by using kilogram for mass and newton for the force.

**A 8.2 Area.** The SI unit of area is the square meter or for large areas square kilometer is used.

**A 8.3 Temperature.** The SI unit of temperature is the Kelvin. However, the use of Celsius (°C) is more predominately used for the SI unit for temperature.

**A 8.4 Time.** The SI unit for times is the second, however, the use of minute, hour, day and year are permissible.

**A 8.5 Angles.** The SI unit for the angle is the radian. The use of arc degree and its decimal submultiples is permissible when the radian in not a convenient unit.

**A 8.6 Volume.** The SI unit for volume is the cubic meter. The use of the liter is restricted to the measurement of liquid and gases. No prefix other than "milli" shall be used with liter.

**A 8.7 Energy.** The SI unit for energy is the joule.

**A 8.8 Torque, Force and Bending Movement.** The SI unit for force and bending movement is the newton. The use of joule should not be used for force and bending movement as this unit is for energy.

**A 8.9 Pressure and Stress.** This SI unit for pressure and stress is the Pascal.

**Table A 8.0 (A)**
**SI BASE QUANTITIES AND UNITS**

| BASE QUANTITY | SI UNIT | SI UNIT SYMBOL |
|---|---|---|
| Length | meter | m |
| Mass | kilogram | kg |
| Time | second | s |
| Electric current | ampere | A |
| Thermodynamic temperature | kelvin | K |
| Amount of a substance | mole | mol |
| Luminous intensity | candela | cd |
| Plane angle | radian | rad |
| Pressure or Stress | kilopascal | kPa |
| Energy | joule | j |
| Volume | cubic meter or liter | $m^3$ or L |
| Force | Newton | N |

**A 9.0 Derived Units.** All other units are defined as "derived units" that are formed by combining the based units and units derived from them accordingly to specific algebraic relations. Table A 9.0 lists derived quantities that are provided with special SI units.

**A 9.1 Factors for Units.** The factors given in Table 9.0 are written as a number equal to or greater than 1 and less than 10, with 6 or fewer decimal places. The number is followed by E, which stands for the exponent, a plus (+) or minus (-) sign, and two digits that indicated the power of 10 by which the number is multiplied.

Examples:
3.523 907 E-02 means 3.523 907 x $10^{-2}$ = 0.035 239 07
3.386 389 E+03 means 3.386 389 x $10^{3}$ = 3386.389

A factor in bold face is exact. All other factors have been rounded to the significant digits given by accepted practice. Where less than six digits, after the decimal place are given, the unit does not warrant a greater number of digits in its conversion.

**A 9.2 Use of Conversion Factors.** Each entry in Table 9.0 shall be interpreted as in these two examples as follows:

| To convert from | to | Multiply by |
|---|---|---|
| atmosphere, standard (atm) | pascal (Pa) | **1.01325 E+05** |
| cubic foot per second ($ft.^3/s$) | cubic meter per second ($m^3/s$) | 2.831 685 E-02 |

means 1 atm = 101 325 Pa (exactly);
1 $ft.^3/s$ = 0.028 316 85 $m^3/s$

To express, for example, the pressure p = 11.8 standard atmospheres (atm) in pascals (Pa), write p = 11.8 atm x 101 325 Pa/atm and obtain the converted numerical value 11.8 x 101 325 = 1 195 635 and the converted value p = 1.20 MPa.

**A 9.3 Conversion and Rounding Numbers.** Conversion is a multi-step process that involves multiplication or division by a numerical factor, selection of the correct number of significant digits, and rounding. The following sections are intended as a guide through this multi-step process.

Conversion factors from the US to SI units are given in Table A9.0, generally to seven significant digits. The first column, labeled **To Convert From**, lists US measurements commonly used to express the quantities; the second column, labeled **To**, gives SI units or other preferred units; and the third column, labeled **Multiply By**, gives the conversion factor by which the numerical value in **To Convert From** units must be multiplied to obtain the numerical value in **To** units.

For example, if the inch-pound value is expressed by a combination of units such as feet and inches, or pounds and ounces, it should first be converted to the smaller units.

Example: 12 feet 5 inches = 149 inches
1 pound 3½ ounces =19.5 ounces

For conversion from inch-pound units to SI units, multiply by the factor. For example, to convert 10.1 feet to meters multiple by 0.3048:

10.1 feet x 0.3048 = 3.07848 m

At this point keep all of the digits, especially if other mathematical operations or conversions will follow. **Rounding should be the last step of the conversion process and performed only once.**

**A 9.3.1 Rounding Numbers.** Before attempting to round a converted number, it is important to establish the purpose of rounding and the application used. Converted values that are being used to develop a technical document, rounding the converted number should maintain the precision of the measurement. Where the measurement represents a maximum or minimum limit, the rounding must be done in a direction where the metric value does not violate the original limit by increasing or decreasing it inappropriately as follows:

(1) If the **first** significant digit of the converted value is **greater than** or **equal** to the **first** significant digit of the original value, round the converted value to the **same** number of significant digits as there are in the original value.

Examples: In converting 60.5 miles to kilometers, first multiply **To Convert from (**US) value by the conversion factor.

**6**0.5 miles x 1.609347 = **9**7.36549 km

The **first** significant digit of the metric value (9) is **greater than** the **first** significant digit of the US value (6). Therefore, the number of significant digits to be retained in the converted value is the same as that for the original value (3 digits), and the result is 97.4 km. If the digits to be discarded begin with a 5 or more and, at least, one of the following digits is greater than 0, the digit preceding the 5 is increased by 1 (e.g., 97.36549 rounded to 97.4)

similarly, in converting 11 miles to kilometers: 11 miles x 1.609347 = **1**7.70281 km

The **first** significant digit of the metric value (1) is **equal to** the **first** significant digit of the of the US value (1). Therefore, the number of significant digits to be retained in the converted value is the **same** as that of the original value of (2 digits), and the result is 18 km.

(2) If the **first** significant digit of the converted value is **smaller** than the **first** significant digit of the original value, round to **one more** significant digit.

Examples: In converting 66 miles to kilometers, first multiply **To Convert From** (US) value by the conversion factor.

**6**6 x 1.609347 = **1**06.2169 km

The **first** significant digit of the metric value (1) is **smaller** than the **first** significant digit of the US value (6). Therefore, the number of significant digits to be retained in the converted value should be **one more** than that for the original value of (3 digits), and the result is 106 km.

Similarly, in converting 8 feet to meters:

**8** feet x 0.3048 = **2**.438400 m

The **first** significant digit of the metric value (2) is **smaller** than the **first** significant digit of the US value (8). Therefore, the number of significant digits to be retained in the converted value should be **one more** than that for the original value of (2 digits), and the result is 2.4 m. If the digits to be discarded begin with a digit less than 5 then the digit preceding the 5 is not changed (e.g., 2.438400 rounded to 2.4)

**TABLE A 8.0 (B)**
**COMMON SI UNITS**

| QUANTITY | UNIT | SI UNIT SYMBOL | FORMULA |
|---|---|---|---|
| Acceleration | meter per second squared | — | $m/s^2$ |
| Angular velocity | radian per second | — | rad/s |
| Area | square meter | — | $m^2$ |
| Density | kilogram per cubic meter | — | $kg/m^3$ |
| Electric potential | volt | V | W/A |
| Electric force | volt | V | W/A |
| Energy | joule | J | N • m |
| Force | newton | N | $kg • m/s^2$ |
| Frequency | hertz | Hz | 1/s |
| Power | watt | W | J/s |
| Pressure | pascal | Pa | $N/m^2$ |
| Quantity of heat | joule | J | N • m |
| Specific heat capacity | joule per kilogram kelvin | — | J/kg • K |
| Stress | pascal | Pa | $N/m^2$ |
| Thermal conductivity | watt per meter kelvin | — | W/m • K |
| Velocity | meter per second | — | m/s |
| Voltage | volt | V | W/A |
| Volume | cubic meter | — | $m^3$ |

**TABLE A 9.0**
**FACTORS FOR UNITS LISTED ALPHABETICALLY**
NATIONAL INSTITUE OF STANDARDS AND TECHNOLOGY
(NIST) FACTORS IN **BOLDFACE** ARE EXACT

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| abampere | ampere (A) | **1.0** | **E+01** |
| abcoulomb | coulomb (C) | **1.0** | **E+01** |
| abfarad | farad (F) | **1.0** | **E+09** |
| abhenry | henry (H) | **1.0** | **E-09** |
| abmho | siemens (S) | **1.0** | **E+09** |
| abohm | ohm (Ω) | **1.0** | **E-09** |
| abvolt | volt (V) | **1.0** | **E-08** |
| acceleration of free fall, standard ($g_n$) | meter per second squared ($m/s^2$) | **9.806 65** | **E+00** |
| acre (based on U.S. survey foot) | square meter ($m^2$) | 4.046 873 | E+03 |
| acre foot (based on U.S. survey foot) | cubic meter ($m^3$) | 1.233 489 | E+03 |
| *ampere hour* (A•h) | coulomb (C) | **3.6** | **E+03** |
| ångström (Å) | meter (m) | **1.0** | **E-10** |
| ångström (Å) | nanometer (nm) | **1.0** | **E-01** |
| are (a) | square meter ($m^2$) | **1.0** | **E+02** |
| *astronomical unit* (ua) | meter (m) | 1.495 979 | E+11 |
| atmosphere, standard (atm) | pascal (Pa) | **1.013 25** | **E+05** |
| atmosphere, standard (atm) | kilopascal (kPa) | **1.013 25** | **E+02** |
| atmosphere, technical (at) | pascal (Pa) | **9.806 65** | **E+04** |
| atmosphere, technical (at) | kilopascal (kPa) | **9.806 65** | **E+01** |
| | | | |
| *bar* (bar) | pascal (Pa) | **1.0** | **E+05** |
| *bar* (bar) | kilopascal (kPa) | **1.0** | **E+02** |
| *barn* (b) | square meter ($m^2$) | **1.0** | **E-28** |
| barrel [for petroleum, 42 gallons (U.S.)](bbl) | cubic meter ($m^3$) | 1.589 873 | E-01 |
| barrel [for petroleum, 42 gallons (U.S.)](bbl) | liter (L) | 1.589 873 | E+02 |
| biot (Bi) | ampere (A) | **1.0** | **E+01** |
| British thermal $unit_{IT}$ ($Btu_{IT}$) | joule (J) | 1.055 056 | E+03 |
| British thermal $unit_{th}$ ($Btu_{IT}$) | joule (J) | 1.054 350 | E+03 |
| British thermal unit (mean) (Btu) | joule (J) | 1.055 87 | E+03 |
| British thermal unit (39°F) (Btu) | joule (J) | 1.059 67 | E+03 |
| British thermal unit (59°F) (Btu) | joule (J) | 1.054 80 | E+03 |
| British thermal unit (60°F) (Btu) | joule (J) | 1.054 68 | E+03 |
| British thermal $unit_{IT}$ foot per hour square foot degree Fahrenheit [$Btu_{IT}$•ft/(h•$ft^2$•°F)] | watt per meter kelvin [W/(m•K)] | 1.730 735 | E+00 |
| British thermal $unit_{th}$ foot per hour square foot degree Fahrenheit [$Btu_{th}$•ft/(h•$ft^2$•°F)] | watt per meter kelvin [W/(m•K)] | 1.729 577 | E+00 |
| British thermal $unit_{IT}$ inch per hour square foot degree Fahrenheit [$Btu_{IT}$•in/(h•$ft^2$•°F)] | watt per meter kelvin [W/(m•K)] | 1.442 279 | E-01 |
| British thermal $unit_{th}$ inch per hour square foot degree Fahrenheit [$Btu_{th}$•in/(h•$ft^2$•°F)] | watt per meter kelvin [W/(m•K)] | 1.441 314 | E-01 |
| British thermal $unit_{IT}$ inch per second square foot degree Fahrenheit [$Btu_{IT}$•in/(s•$ft^2$•°F)] | watt per meter kelvin [W/(m•K)] | 5.192 204 | E+02 |
| British thermal $unit_{th}$ inch per second square foot degree Fahrenheit [$Btu_{th}$•in/(s•$ft^2$•°F)] | watt per meter kelvin [W/(m•K)] | 5.188 732 | E+02 |
| British thermal $unit_{IT}$ per cubic foot ($Btu_{IT}/ft^3$) | joule per cubic meter ($J/m^3$) | 3.725 895 | E+04 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| British thermal unit$_{th}$ per cubic foot | joule per cubic meter (J/m$^3$) | 3.723 403 | E+04 |
| British thermal unit$_{IT}$ per cubic foot | kilowatt hour per liter (kW•h/L) | 1.034971 | E-05 |
| British thermal unit$_{th}$ per cubic foot | kilowatt hour per liter (kW•h/L) | 1.034279 | E-05 |
| British thermal unit$_{IT}$ per degree Fahrenheit (Btu$_{IT}$/°F) | joule per kelvin (J/K) | 1.899 101 | E+03 |
| British thermal unit$_{th}$ per degree Fahrenheit (Btu$_{th}$/°F) | joule per kelvin (J /K) | 1.897 830 | E+03 |
| British thermal unit$_{IT}$ per degree Rankine (Btu$_{IT}$/°R) | joule per kelvin (J/K) | 1.899 101 | E+03 |
| British thermal unit$_{th}$ per degree Rankine (Btu$_{th}$/°R) | joule per kelvin (J/K) | 1.897 830 | E+03 |
| British thermal unit$_{IT}$ per hour (Btu$_{IT}$/h) | kilowatt (kW) | 2.930 711 | E-04 |
| British thermal unit$_{th}$ per hour (Btu$_{th}$/h) | kilowatt (kW) | 2.928 751 | E-04 |
| British thermal unit$_{IT}$ per hour per cubic foot [(Btu$_{IT}$/h)/ft.$^3$] | Kilowatt per cubic meter (kW/m$^3$) | 1.034971 | E-02 |
| British thermal unit$_{th}$ per hour per cubic foot [(Btu$_{th}$/h)/ft.$^3$] | Kilowatt per cubic meter (kW/m$^3$) | 1.034279 | E-02 |
| British thermal unit$_{IT}$ per hour square foot degree Fahrenheit [Btu$_{IT}$/(h•ft$^2$•°F)] | watt per square meter kelvin [W/(m$^2$•K)] | 5.678 263 | E+00 |
| British thermal unit$_{th}$ per hour square foot degree Fahrenheit [Btu$_{th}$/(h•ft$^2$•°F)] | watt per square meter kelvin [W/(m$^2$•K)] | 5.674 466 | E+00 |
| British thermal unit$_{th}$ per minute (Btu$_{th}$/min) | watt (W) | 1.757 250 | E+01 |
| British thermal unit$_{IT}$ per pound (Btu$_{IT}$/lb.) | joule per kilogram (J/kg) | **2.326** | **E+03** |
| British thermal unit$_{th}$ per pound (Btu$_{th}$/lb.) | joule per kilogram (J/kg) | 2.324 444 | E+03 |
| British thermal unit$_{IT}$ per pound degree Fahrenheit [Btu$_{IT}$/(lb.•°F)] | joule per kilogram kelvin [J/(kg•K)] | **4.1868** | **E+03** |
| British thermal unit$_{th}$ per pound degree Fahrenheit [Btu$_{th}$/(lb.•°F)] | joule per kilogram kelvin [J/(kg•K)] | **4.184** | **E+03** |
| British thermal unit$_{IT}$ per pound degree Rankine [Btu$_{IT}$/(lb.•°R)] | joule per kilogram kelvin [J/(kg•K)] | **4.1868** | **E+03** |
| British thermal unit$_{th}$ per pound degree Rankine [Btu$_{th}$/(lb.•°R)] | joule per kilogram kelvin [J/(kg•K)] | **4.184** | **E+03** |
| British thermal unit$_{IT}$ per second (Btu$_{IT}$/s) | watt (W) | 1.055 056 | E+03 |
| British thermal unit$_{th}$ per second (Btu$_{th}$/s) | watt (W) | 1.054 350 | E+03 |
| British thermal unit$_{IT}$ per second square foot degree Fahrenheit [Btu$_{IT}$/(s•ft$^2$•°F)] | watt per square meter kelvin [W/(m$^2$•K)] | 2.044 175 | E+04 |
| British thermal unit$_{th}$ per second square foot degree Fahrenheit [Btu$_{th}$/(s•ft$^2$•°F)] | watt per square meter kelvin [W/(m$^2$•K)] | 2.042 808 | E+04 |
| British thermal unit$_{IT}$ per square foot [Btu$_{IT}$/ft.$^2$) | joule per square meter (J/m$^2$) | 1.135 653 | E+04 |
| British thermal unit$_{th}$ per square foot [Btu$_{th}$/ft.$^2$) | joule per square meter (J/m$^2$) | 1.134 893 | E+04 |
| British thermal unit$_{IT}$ per square foot hour [Btu$_{IT}$/(ft.$^2$•h)] | watt per square meter (W/m$^2$) | 3.154 591 | E+00 |
| British thermal unit$_{th}$ per square foot hour [Btu$_{th}$/(ft.$^2$•h)] | watt per square meter (W/m$^2$) | 3.152 481 | E+00 |
| British thermal unit$_{th}$ per square foot-minute [Btu$_{th}$/(ft.$^2$•min)] | watt per square meter (W/m$^2$) | 1.891 489 | E+02 |
| British thermal unit$_{IT}$ per square foot second [Btu$_{IT}$/(ft.$^2$•s)] | watt per square meter (W/m$^2$) | 1.135 653 | E+04 |
| British thermal unit$_{th}$ per square foot second [Btu$_{th}$/(ft.$^2$•s)] | watt per square meter (W/m$^2$) | 1.134 893 | E+04 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| British thermal unit$_{th}$ per square inch second [Btu$_{th}$/(in$^2$•s)] | watt per square meter (W/m$^2$) | 1.634 246 | E+06 |
| bushel (U.S.) (bu) | cubic meter (m$^3$) | 3.523 907 | E-02 |
| bushel (U.S.) (bu) | liter (L) | 3.523 907 | E+01 |
| | | | |
| calorie$_{IT}$ (cal$_{IT}$) | joule (J) | **4.1868** | **E+00** |
| calorie$_{th}$ (cal$_{th}$) | joule (J) | **4.184** | **E+00** |
| calorie (cal) (mean) | joule (J) | 4.190 02 | E+00 |
| calorie (15°C) (cal) | joule (J) | 4.185 80 | E+00 |
| calorie (20°C) (cal) | joule (J) | 4.181 90 | E+00 |
| calorie$_{IT,}$ kilogram (nutrition) | joule (J) | **4.1868** | **E+03** |
| calorie $_{th,}$ kilogram (nutrition) | joule (J) | **4.184** | **E+03** |
| calorie (mean), kilogram (nutrition) | joule (J) | 4.190 02 | E+03 |
| calorie$_{th}$ per centimeter second degree Celsius [cal$_{th}$/(cm•s•°C)] | watt per meter kelvin [W/ (m•K)] | **4.184** | **E+02** |
| calorie$_{IT}$ per gram (cal$_{IT}$/g) | joule per kilogram (J/kg) | **4.1868** | **E+03** |
| calorie$_{th}$ per gram (cal$_{th}$/g) | joule per kilogram (J/kg) | **4.184** | **E+03** |
| calorie$_{IT}$ per gram degree Celsius | | | |
| [cal$_{IT}$/(g•°C)] | joule per kilogram kelvin [J/(kg•K)] | **4.1868** | **E+03** |
| calorie$_{th}$ per gram degree Celsius [cal$_{th}$/(g•°C)] | joule per kilogram kelvin (J/(kg•K)] | **4.184** | **E+03** |
| calorie$_{IT}$ per gram kelvin [cal$_{IT}$/(g•K)] | joule per kilogram kelvin (J/(kg•K)] | **4.1868** | **E+03** |
| calorie$_{th}$ per gram kelvin [cal$_{th}$/(g•K)] | joule per kilogram kelvin (J/(kg•K)] | **4.184** | **E+03** |
| calorie$_{th}$ per minute (cal$_{th}$/min) | watt (W) | 6.973 333 | E-02 |
| calorie$_{th}$ per second (cal$_{th}$/s) | watt (W) | **4.184** | **E+00** |
| calorie$_{th}$ per square centimeter (cal$_{th}$/cm$^2$) | joule per square meter (J/m$^2$) | **4.184** | **E+04** |
| calorie$_{th}$ per square centimeter minute [cal$_{th}$/(cm$^2$•min)] | watt per square meter (W/m$^2$) | 6.973 333 | E+02 |
| calorie$_{th}$ per square centimeter second [cal$_{th}$/(cm$^2$•s)] | watt per square meter (W/m$^2$) | **4.184** | **E+04** |
| candela per square inch (cd/in$^2$) | candela per square meter (cd/m$^2$) | 1.550 003 | E+03 |
| carat, metric | kilogram (kg) | **2.0** | **E-04** |
| carat, metric | gram (g) | **2.0** | **E-01** |
| centimeter of mercury (0°C) | pascal (Pa) | 1.333 22 | E+03 |
| centimeter of mercury (0°C) | kilopascal (kPa) | 1.333 22 | E+00 |
| centimeter of mercury, conventional (cmHg) | pascal (Pa) | 1.333 224 | E+03 |
| centimeter of mercury, conventional (cmHg) | kilopascal (kPa) | 1.333 224 | E+00 |
| centimeter of water (4°C) | pascal (Pa) | 9.806 38 | E+01 |
| centimeter of water, conventional (cm$H_2O$) | pascal (Pa) | **9.806 65** | **E+01** |
| centipoise (cP) | pascal second (Pa•s) | **1.0** | **E-03** |
| centistokes (cSt) | meter squared per second (m$^2$/s) | **1.0** | **E-06** |
| chain (based on U.S. survey foot) (ch) | meter (m) | 2.011 684 | E+01 |
| circular mil | square meter (m$^2$) | 5.067 075 | E-10 |
| circular mil | square millimeter (mm$^2$) | 5.067 075 | E-04 |
| clo | square meter kelvin per watt (m$^2$•K/ W) | 1.55 | E-01 |
| cord (128 ft$^3$) | cubic meter (m$^3$) | 3.624 556 | E+00 |
| cubic foot (ft$^3$) | cubic meter (m$^3$) | 2.831 685 | E-02 |
| cubic foot per British thermal unit$_{IT}$ per hour [ft$^3$/(Btu$_{IT}$/h)] | cubic meter per kilowatt (m$^3$/kW) | 9.662109 | E+01 |
| cubic foot per British thermal unit$_{th}$ per hour [ft$^3$/(Btu$_{th}$/h)] | cubic meter per kilowatt (m$^3$/kW) | 9.668571 | E+01 |
| cubic foot per hour (ft$^3$/h) | cubic meter per hour (m$^3$/h) | 2.831685 | E-02 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| cubic foot per minute ($ft^3$/min) | cubic meter per minute ($m^3$/min) | 2.831 685 | E-02 |
| cubic foot per minute ($ft^3$/min) | cubic meter per second ($m^3$/s) | 4.719474 | E-04 |
| cubic foot per minute ($ft^3$/min) | liter per second (L/s) | 4.719 474 | E-01 |
| cubic foot per minute per foot [($ft^3$/min)/ft] | cubic meter per second per meter [($m^3$/s)/m] | 1.547368 | E-03 |
| cubic foot per minute per square foot [($ft^3$/min)/$ft^2$] | cubic meter per second per square meter [($m^3$/s)/$m^2$] | 5.08 | E-03 |
| cubic foot per pound ($ft^3$/lb) | cubic meter per kilogram ($m^3$/kg) | 6.242796 | E-02 |
| cubic foot per second ($ft^3$/s) | cubic meter per second ($m^3$/s) | 2.831 685 | E-02 |
| cubic inch ($in^3$) | cubic meter ($m^3$) | 1.638 706 | E-05 |
| cubic inch per minute ($in^3$/min) | cubic meter per second ($m^3$/s) | 2.731 177 | E-07 |
| cubic mile ($mi^3$) | cubic meter ($m^3$) | 4.168 182 | E+09 |
| cubic yard ($yd^3$) | cubic meter ($m^3$) | 7.645 549 | E-01 |
| cubic yard per minute ($yd^3$/min) | cubic meter per second ($m^3$/s) | 1.274 258 | E-02 |
| cup (U.S.) | cubic meter ($m^3$) | 2.365 882 | E-04 |
| cup (U.S.) | liter (L) | 2.365 882 | E-01 |
| cup (U.S.) | milliliter (mL) | 2.365 882 | E+02 |
| *curie* (Ci) | becquerel (Bq) | **3.7** | **E+10** |
| | | | |
| darcy | meter squared ($m^2$) | 9.869 233 | E-13 |
| *day* (d) | second (s) | **8.64** | **E+04** |
| day (sidereal) | second (s) | 8.616 409 | E+04 |
| debye (D) | coulomb meter (C•m) | 3.335 641 | E-30 |
| *degree* (angle) (°) | radian (rad) | 1.745 329 | E-02 |
| *degree Celsius* (temperature) (°C) | kelvin (K) | K=°C+**273.15** | |
| *degree Celsius* (temperature interval) (°C) | kelvin (K) | **1.0** | **E+00** |
| degree centigrade (temperature) | degree Celsius (°C) | °C ≈ deg. cent. | |
| degree centigrade (temperature interval) | degree Celsius (°C) | 1.0 | E+00 |
| degree Fahrenheit (temperature) (°F) | degree Celsius (°C) | °C = (°F–**32**)/**1.8** | |
| degree Fahrenheit (temperature) (°F) | kelvin (K) | K = (°F + **459.67**)/**1.8** | |
| degree Fahrenheit (temperature interval) (°F) | degree Celsius (°C) | 5.555 556 | E-01 |
| degree Fahrenheit (temperature interval) (°F) | kelvin (K) | 5.555 556 | E-01 |
| degree Fahrenheit hour per British thermal $unit_{IT}$ (°F•h/$Btu_{IT}$) | kelvin per watt (K/W) | 1.895 634 | E+00 |
| degree Fahrenheit hour per British thermal $unit_{th}$ (°F•h/ $Btu_{th}$) | kelvin per watt (K/W) | 1.896 903 | E+00 |
| degree Fahrenheit hour square foot per British thermal $unit_{IT}$ (°F•h•$ft^2$/$Btu_{IT}$) | square meter kelvin per watt ($m^2$•K/W) | 1.761 102 | E-01 |
| degree Fahrenheit hour square foot per British thermal $unit_{th}$ (°F•h•$ft^2$/$Btu_{th}$) | square meter kelvin per watt ($m^2$•K/W) | 1.762 280 | E-01 |
| degree Fahrenheit hour square foot per British thermal $unit_{IT}$ inch [°F•h•$ft^2$/($Btu_{IT}$•in)] | meter kelvin per watt (m•K/W) | 6.933 472 | E+00 |
| degree Fahrenheit hour square foot per British thermal $unit_{th}$ inch [°F•h•$ft^2$/($Btu_{th}$•in)] | meter kelvin per watt (m•K/W) | 6.938 112 | E+00 |
| degree Fahrenheit second per British thermal $unit_{IT}$ (°F•s/$Btu_{IT}$) | kelvin per watt (K/W) | 5.265 651 | E-04 |
| degree Fahrenheit second per British thermal $unit_{th}$ (°F•s/$Btu_{th}$) | kelvin per watt (K/W) | 5.269 175 | E-04 |
| degree Rankine (°R) | kelvin (K) | K = (°R)/**1.8** | |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| degree Rankine (temperature interval) (°R) | kelvin (K) | 5.555 556 | E-01 |
| denier | kilogram per meter (kg/m) | 1.111 111 | E-07 |
| denier | gram per meter (g/m) | 1.111 111 | E-04 |
| dyne (dyn) | newton (N) | **1.0** | **E-05** |
| dyne centimeter (dyn•cm) | newton meter (N•m) | **1.0** | **E-07** |
| dyne per square centimeter (dyn/cm$^2$) | pascal (Pa) | **1.0** | **E-01** |
| | | | |
| *electronvolt* (eV) | joule (J) | 1.602 176 | E-19 |
| EMU of capacitance (abfarad) | farad (F) | **1.0** | **E+09** |
| EMU of current (abampere) | ampere (A) | **1.0** | **E+01** |
| EMU of Electric potential (abvolt) | volt (V) | **1.0** | **E-08** |
| EMU of inductance (abhenry) | henry (H) | **1.0** | **E-09** |
| EMU of resistance (abohm) | ohm (Ω) | **1.0** | **E-09** |
| erg (erg) | joule (J) | **1.0** | **E-07** |
| erg per second (erg/s) | watt (W) | **1.0** | **E-07** |
| erg per square centimeter second | watt per square meter (W/m$^2$) | **1.0** | **E-03** |
| ESU of capacitance (statfarad) | farad (F) | 1.112 650 | E-12 |
| ESU of current (statampere) | ampere (A) | 3.335 641 | E-10 |
| ESU of Electric potential (statvolt) | volt (V) | 2.997 925 | E+02 |
| ESU of inductance (stathenry) | henry (H) | 8.987 552 | E+11 |
| ESU of resistance (statohm) | ohm (Ω) | 8.987 552 | E+11 |
| | | | |
| faraday (based on carbon 12) | coulomb (C) | 9.648 534 | E+04 |
| fathom (based on U.S. survey foot) | meter (m) | 1.828 804 | E+00 |
| fermi | meter (m) | **1.0** | **E-15** |
| fermi | femtometer (fm) | **1.0** | **E+00** |
| fluid ounce (U.S.) (fl oz) | cubic meter (m$^3$) | 2.957 353 | E-05 |
| fluid ounce (U.S.) (fl oz) | milliliter (mL) | 2.957 353 | E+01 |
| foot (ft) | meter (m) | **3.048** | **E-01** |
| foot (U.S. survey) (ft) | meter (m) | 3.048 006 | E-01 |
| footcandle | lux (lx) | 1.076 391 | E+01 |
| footlambert | candela per square meter (cd/m$^2$) | 3.426 259 | E+00 |
| foot of mercury, conventional (ftHg) | pascal (Pa) | 4.063 666 | E+04 |
| foot of mercury, conventional (ftHg) | kilopascal (kPa) | 4.063 666 | E+01 |
| foot of water (39.2°F) | pascal (Pa) | 2.988 98 | E+03 |
| foot of water (39.2°F) | kilopascal (kPa) | 2.988 98 | E+00 |
| foot of water, conventional (ft$H_2O$) | pascal (Pa) | 2.989 067 | E+03 |
| foot of water, conventional (ft$H_2O$) | kilopascal (kPa) | 2.989 067 | E+00 |
| foot per hour (ft/h) | meter per second (m/s) | 8.466 667 | E-05 |
| foot per minute (ft/min) | meter per second (m/s) | **5.08** | **E-03** |
| foot per second (ft/s) | meter per second (m/s) | **3.048** | **E-01** |
| foot per second squared (ft/s$^2$) | meter per second squared (m/s$^2$) | **3.048** | **E-01** |
| foot poundal | joule (J) | 4.214 011 | E-02 |
| foot pound-force (ft•lbf) | joule (J) | 1.355 818 | E+00 |
| foot pound-force per hour (ft•lbf/h) | watt (W) | 3.766 161 | E-04 |
| foot pound-force per minute (ft•lbf/min) | watt (W) | 2.259 697 | E-02 |
| foot pound-force per second (ft•lbf/s) | watt (W) | 1.355 818 | E+00 |
| foot to the fourth power (ft$^4$) | meter to the fourth power (m$^4$) | 8.630 975 | E-03 |
| franklin (Fr) | coulomb (C) | 3.335 641 | E-10 |
| | | | |
| gal (Gal) | meter per second squared (m/s$^2$) | **1.0** | **E-02** |
| gallon [Canadian and U.K. (Imperial)] (gal) | cubic meter (m$^3$) | **4.546 09** | **E-03** |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| gallon [Canadian and U.K. (Imperial)] (gal) | liter (L) | **4.546 09** | **E+00** |
| gallon (U.S. liquid) (gal) | cubic meter ($m^3$) | 3.785 412 | E-03 |
| gallon (U.S. liquid) (gal) | liter (L) | 3.785 412 | E+00 |
| gallon (U.S.) per day (gal/d) | cubic meter per second ($m^3/s$) | 4.381 264 | E-08 |
| gallon (U.S.) per day (gal/d) | liter per day (L/d) | 3.7855412 | E+00 |
| gallon (U.S.) per day (gal/d) | liter per second (L/s) | 4.381 264 | E-05 |
| gallon (U.S.) per horsepower hour [gal/(hp•h)] | cubic meter per joule ($m^3/J$) | 1.410 089 | E-09 |
| gallon (U.S.) per horsepower hour [gal/(hp•h)] | liter per joule (L/J) | 1.410 089 | E-06 |
| gallon (U.S.) per minute (gpm) (gal/min) | cubic meter per minute ($m^3$/min) | 3.785 412 | E-03 |
| gallon (U.S.) per minute (gpm) (gal/min) | liter per second (L/s) | 6.309 020 | E-02 |
| gallon per minute per ton (metric) [(gal/min)/ton] | liter per second per kilogram [(L/s)/kg] | 6.30902 | E-05 |
| gallon (U.S.) per square foot (gal/$ft^2$) | liter per square meter ($L/m^2$) | 4.074584 | E+01 |
| gamma ($\gamma$) | tesla (T) | **1.0** | **E-09** |
| gauss (Gs, G) | tesla (T) | **1.0** | **E-04** |
| gilbert (Gi) | ampere (A) | 7.957 747 | E-01 |
| gill [Canadian and UK (Imperial)] (gi) | cubic meter ($m^3$) | 1.420 653 | E-04 |
| gill [Canadian and UK (Imperial)] (gi) | liter (L) | 1.420 653 | E-01 |
| gill (U.S.) (gi) | cubic meter ($m^3$) | 1.182 941 | E-04 |
| gill (U.S.) (gi) | liter (L) | 1.182 941 | E-01 |
| gon (also called grade) (gon) | radian (rad) | 1.570 796 | E-02 |
| gon (also called grade) (gon) | degree (angle) (°) | **9.0** | **E-01** |
| grain (gr) | kilogram (kg) | **6.479 891** | **E-05** |
| grain (gr) | milligram (mg) | **6.479 891** | **E+01** |
| grain per cubic foot (gr/$ft^3$) | milligram per liter (mg/L) | 2.288352 | E+00 |
| grain per gallon (U .S.) (gr/gal) | kilogram per cubic meter ($kg/m^3$) | 1.711 806 | E-02 |
| grain per gallon (U.S.) (gr/gal) | milligram per liter (mg/L) | 1.711 806 | E+01 |
| gram-force per square centimeter (gf/$cm^2$) | pascal (Pa) | **9.806 65** | **E+01** |
| *gram per cubic centimeter* (g/$cm^3$) | kilogram per cubic meter ($kg/m^3$) | **1.0** | **E+03** |
| | | | |
| *hectare* (ha) | square meter ($m^2$) | **1.0** | **E+04** |
| horsepower (550 ft•lbf/s) (hp) | watt (W) | 7.456 999 | E+02 |
| horsepower (boiler) | watt (W) | 9.809 50 | E+03 |
| horsepower (electric) | watt (W) | **7.46** | **E+02** |
| horsepower (electric) | kilowatt (kW) | **7.46** | **E-01** |
| horsepower (metric) | watt (W) | 7.354 988 | E+02 |
| horsepower (U.K.) | watt (W) | 7.4570 | E+02 |
| horsepower (water) | watt (W) | 7.460 43 | E+02 |
| *hour* (h) | second (s) | **3.6** | **E+03** |
| hour (sidereal) | second (s) | 3.590 170 | E+03 |
| hundredweight (long, 112 lb) | kilogram (kg) | 5.080 235 | E+01 |
| hundredweight (short, 100 lb) | kilogram (kg) | 4.535 924 | E+01 |
| | | | |
| inch (in) | meter (m) | **2.54** | **E-02** |
| inch (in) | centimeter (cm) | **2.54** | **E+00** |
| inch of mercury (32°F) | pascal (Pa) | 3.386 38 | E+03 |
| inch of mercury (32°F) | kilopascal (kPa) | 3.386 38 | E+00 |
| inch of mercury (60°F) | pascal (Pa) | 3.376 85 | E+03 |
| inch of mercury (60°F) | kilopascal (kPa) | 3.376 85 | E+00 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| inch of mercury, conventional (inHg) | pascal (Pa) | 3.386 389 | E+03 |
| inch of mercury, conventional (inHg) | kilopascal (kPa) | 3.386 389 | E+00 |
| inch of water (39.2°F) | kilopascal (kPa) | 2.490 82 | E-01 |
| inch of water (60°F) | kilopascal (kPa) | 2.4884 | E-01 |
| inch of water, conventional (in$H_2O$) | kilopascal (kPa) | 2.490 889 | E-01 |
| inch per foot (in/ft) | millimeter per meter (mm/m) | 8.327869 | E+01 |
| inch per hour (in/h) | millimeter per hour (mm/h) | 2.54 | E+01 |
| inch per second (in/s) | meter per second (m/s) | **2.54** | **E-02** |
| inch per second squared (in/$s^2$) | meter per second squared ($m/s^2$) | **2.54** | **E-02** |
| inch to the fourth power ($in^4$) | meter to the fourth power ($m^4$) | 4.162 314 | E-07 |
| | | | |
| kayser (K) | reciprocal meter ($m^{-1}$) | **1.0** | **E+02** |
| *kelvin* (K) | degree Celsius (°C) | *t*/°C=T/K– | **273.15** |
| $kilocalorie_{IT}$ ($kcal_{IT}$) | joule (J) | **4.1868** | **E+03** |
| $kilocalorie_{th}$ ($kcal_{th}$) | joule (J) | **4.184** | **E+03** |
| kilocalorie (mean) (kcal) | joule (J) | 4.190 02 | E+03 |
| $kilocalorie_{th}$ per minute ($kcal_{th}$/min) | watt (W) | 6.973 333 | E+01 |
| $kilocalorie_{th}$ per second ($kcal_{th}$/s) | watt (W) | **4.184** | **E+03** |
| kilogram-force (kgf) | newton (N) | **9.806 65** | **E+00** |
| kilogram-force meter (kgf•m) | newton meter (N•m) | **9.806 65** | **E+00** |
| kilogram-force per square centimeter ($kgf/cm^2$) | pascal (Pa) | **9.806 65** | **E+04** |
| kilogram-force per square centimeter ($kgf/cm^2$) | kilopascal (kPa) | **9.806 65** | **E+01** |
| kilogram-force per square meter ($kgf / m^2$) | pascal (Pa) | **9.806 65** | **E+00** |
| kilogram-force per square millimeter ($kgf/mm^2$) | pascal (Pa) | **9.806 65** | **E+06** |
| kilogram-force per square millimeter ($kgf/mm^2$) | megapascal (Mpa) | **9.806 65** | **E+00** |
| kilogram-force second squared per meter ($kgf•s^2/m$) | kilogram (kg) | **9.806 65** | **E+00** |
| *kilometer per hour* (km/h) | meter per second (m/s) | 2.777 778 | E-01 |
| kilopond (kilogram-force) (kp) | newton (N) | **9.806 65** | **E+00** |
| *kilowatt hour* (kW•h) | joule (J) | **3.6** | **E+06** |
| *kilowatt hour* (kW•h) | megajoule (MJ) | **3.6** | **E+00** |
| kip (1 kip=1000 lbf) | newton (N) | 4.448 222 | E+03 |
| kip (1 kip=1000 lbf) | kilonewton (kN) | 4.448 222 | E+00 |
| kip per square inch (ksi) ($kip/in^2$) | pascal (Pa) | 6.894 757 | E+06 |
| kip per square inch (ksi) ($kip/in^2$) | kilopascal (kPa) | 6.894 757 | E+03 |
| *knot* (nautical mile per hour) | meter per second (m/s) | 5.144 444 | E-01 |
| | | | |
| lambert | candela per square meter ($cd/m^2$) | 3.183 099 | E+03 |
| langley ($calth/cm^2$) | joule per square meter ($J/m^2$) | **4.184** | **E+04** |
| light year (l.y.) | meter (m) | 9.460 73 | E+15 |
| *liter* (L) | cubic meter ($m^3$) | **1.0** | **E-03** |
| lumen per square foot ($1m/ft^2$) | lux (lx) | 1.076 391 | E+01 |
| | | | |
| maxwell (Mx) | weber (Wb) | **1.0** | **E-08** |
| mho | siemens (S) | **1.0** | **E+00** |
| microinch | meter (m) | **2.54** | **E-08** |
| microinch | micrometer (μm] | **2.54** | **E-02** |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| micron (μ) | meter (m) | **1.0** | **E-06** |
| micron (μ) | micrometer (μm) | **1.0** | **E+00** |
| mil (0.001 in) | meter (m) | **2.54** | **E-05** |
| mil (0.001 in) | millimeter (mm) | **2.54** | **E-02** |
| mil (angle) | radian (rad) | 9.817 477 | E-04 |
| mil (angle) | degree (°) | **5.625** | **E-02** |
| mile (mi) | meter (m) | **1.609 344** | **E+03** |
| mile (mi) | kilometer (km) | **1.609 344** | **E+00** |
| mile (based on U.S. survey foot) (mi) | meter (m) | 1.609 347 | E+03 |
| mile (based on U.S. survey foot) (mi) | kilometer (km) | 1.609 347 | E+00 |
| *mile, nautical* | meter (m) | **1.852** | **E+03** |
| mile per gallon (U.S.) (mpg) (mi/gal) | meter per cubic meter ($m/m^3$) | 4.251 437 | E+05 |
| mile per gallon (U.S.) (mpg) (mi/gal) | kilometer per liter (km/L) | 4.251 437 | E-01 |
| mile per gallon (U.S.) (mpg) (mi/gal) | liter per 100 kilometer (L/100 km) | divide 235.215 by number of miles per gallon | |
| mile per hour (mi/h) | meter per second (m/s) | **4.4704** | **E-01** |
| mile per hour (mi/h) | kilometer per hour (km/h) | **1.609 344** | **E+00** |
| mile per minute (mi/min) | meter per second (m/s) | **2.682 24** | **E+01** |
| mile per second (mi/s) | meter per second (m/s) | **1.609 344** | **E+03** |
| millibar (mbar) | pascal (Pa) | **1.0** | **E+02** |
| millibar (mbar) | kilopascal (kPa) | **1.0** | **E-01** |
| *millimeter of mercury*, conventional (mmHg) | pascal (Pa) | 1.333 224 | E+02 |
| millimeter of water, conventional ($mmH_2O$) | pascal (Pa) | **9.806 65** | **E+00** |
| *minute* (angle) (‘) | radian (rad) | 2.908 882 | E-04 |
| *minute* (min) | second (s) | **6.0** | **E+01** |
| minute (sidereal) | second (s) | 5.983 617 | E+01 |
| | | | |
| oersted (Oe) | ampere per meter (A/m) | 7.957 747 | E+01 |
| *ohm centimeter* (Ω•cm) | ohm meter (Ω•m) | **1.0** | E-02 |
| ohm circular-mil per foot | ohm meter (Ω•m) | 1.662 426 | E-09 |
| ohm circular-mil per foot | ohm square millimeter per meter | | |
| | ($\Omega \cdot mm^2/m$) | 1.662 426 | E-03 |
| ounce (avoirdupois) (oz) | kilogram (kg) | 2.834 952 | E-02 |
| ounce (avoirdupois) (oz) | gram (g) | 2.834 952 | E+01 |
| ounce (troy or apothecary) (oz) | kilogram (kg) | 3.110 348 | E-02 |
| ounce (troy or apothecary) (oz) | gram (g) | 3.110 348 | E+01 |
| ounce [Canadian and U.K. fluid (lmperial)] (f1 oz) | cubic meter ($m^3$) | 2.841 306 | E-05 |
| ounce [Canadian and U.K. fluid (Imperial)] (f1 oz) | milliliter (mL) | 2.841 306 | E+01 |
| ounce (U.S. fluid) (fl oz) | cubic meter ($m^3$) | 2.957 353 | E-05 |
| ounce (U.S. fluid) (f1 oz) | milliliter (mL) | 2.957 353 | E+01 |
| ounce (avoirdupois)-force (ozf) | newton (N) | 2.780 139 | E-01 |
| ounce (avoirdupois)-force inch (ozf•in) | newton meter (N•m) | 7.061 552 | E-03 |
| ounce (avoirdupois)-force inch (ozf•in) | millinewton meter (mN•m) | 7.061 552 | E+00 |
| ounce (avoirdupois) per cubic inch ($oz/in^3$) | kilogram per cubic meter ($kg/m^3$) | 1.729 994 | E+03 |
| ounce (avoirdupois) per gallon [Canadian and U.K. (lmperial)] (oz/gal) | kilogram per cubic meter ($kg/m^3$) | 6.236 023 | E+00 |
| ounce (avoirdupois) per gallon [Canadian and U.K. (Imperial)] (oz/gal) | gram per liter (g/L) | 6.236 023 | E+00 |
| ounce (avoirdupois) per gallon (U.S.) (oz/gal) | kilogram per cubic meter ($kg/m^3$) | 7.489 152 | E+00 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| ounce (avoirdupois) per gallon (U.S.) (oz/gal) | gram per liter (g/L) | 7.489 152 | E+00 |
| ounce (avoirdupois) per square foot (oz/ft$^2$) | kilogram per square meter (kg/m$^2$) | 3.051 517 | E-01 |
| ounce (avoirdupois) per square inch (oz/in$^2$) | kilogram per square meter (kg/m$^2$) | 4.394 185 | E+01 |
| ounce (avoirdupois) per square yard (oz/yd$^2$) | kilogram per square meter (kg/m$^2$) | 3.390 575 | E-02 |
| | | | |
| parsec (pc) | meter (m) | 3.085 678 | E+16 |
| peck (U.S.) (pk) | cubic meter (m$^3$) | 8.809 768 | E-03 |
| peck (U.S.) (pk) | liter (L) | 8.809 768 | E+00 |
| pennyweight (dwt) | kilogram (kg) | 1.555 174 | E-03 |
| pennyweight (dwt) | gram (g) | 1.555 174 | E+00 |
| perm (0°C) | kilogram per pascal second square meter [kg/(Pa•s•m$^2$)] | 5.721 35 | E-11 |
| perm (23°C) | kilogram per pascal second square meter [kg/(Pa•s•m$^2$)] | 5.745 25 | E-11 |
| perm inch (0°C) | kilogram per pascal second meter [kg/(Pa•s•m)] | 1.453 22 | E-12 |
| perm inch (23°C) | kilogram per pascal second meter [kg/(Pa•s•m)] | 1.459 29 | E-12 |
| phot (ph) | lux (lx) | **1.0** | **E+04** |
| pica (computer) (1/6 in) | meter (m) | 4.233 333 | E-03 |
| pica (computer) (1/6 in) | millimeter (mm) | 4.233 333 | E+00 |
| pica (printer's) | meter (m) | 4.217 518 | E-03 |
| pica (printer's) | millimeter (mm) | 4.217 518 | E+00 |
| pint (U.S. dry) (dry pt) | cubic meter (m$^3$) | 5.506 105 | E-04 |
| pint (U.S. dry) (dry pt) | liter (L) | 5.506 105 | E-01 |
| pint (U.S. liquid) (liq pt) | cubic meter (m$^3$) | 4.731 765 | E-04 |
| pint (U.S. liquid) (liq pt) | liter (L) | 4.731 765 | E-01 |
| point (computer) (1/72 in) | meter (m) | 3.527 778 | E-04 |
| point (computer) (1/72 in) | millimeter (mm) | 3.527 778 | E-01 |
| point (printer's) | meter (m) | 3.514 598 | E-04 |
| point (printer's) | millimeter (mm) | 3.514 598 | E-01 |
| poise (P) | pascal second (Pa•s) | **1.0** | **E-01** |
| pound (avoirdupois) (lb) | kilogram (kg) | 4.535 924 | E-01 |
| pound (troy or apothecary) (lb) | kilogram (kg) | 3.732 417 | E-01 |
| poundal | newton (N) | 1.382 550 | E-01 |
| poundal per square foot | pascal (Pa) | 1.488 164 | E+00 |
| poundal second per square foot | pascal second (Pa•s) | 1.488 164 | E+00 |
| pound foot squared (lb•ft$^2$) | kilogram meter squared (kg•m$^2$) | 4.214 011 | E-02 |
| pound-force (lbf) | newton (N) | 4.448 222 | E+00 |
| pound-force foot (lbf•ft) | newton meter (N•m) | 1.355 818 | E+00 |
| pound-force foot per inch (lbf•ft/in) | newton meter per meter (N•m/m) | 5.337 866 | E+01 |
| pound-force inch (lbf•in) | newton meter (N•m) | 1.129 848 | E-01 |
| pound-force inch per inch (lbf•in/in) | newton meter per meter (N•m/m) | 4.448 222 | E+00 |
| pound-force per foot (lbf/ft) | newton per meter (N/m) | 1.459 390 | E+01 |
| pound-force per inch (lbf/in) | newton per meter (N/m) | 1.751 268 | E+02 |
| pound-force per pound (lbf/lb) (thrust to mass ratio) | newton per kilogram (N/kg) | **9.806 65** | **E+00** |
| pound-force per square foot (lbf/ft$^2$) | pascal (Pa) | 4.788 026 | E+01 |
| pound-force per square inch (psi) (lbf/in$^2$) | pascal (Pa) | 6.894 757 | E+03 |
| pound-force per square inch (psi) (lbf/in$^2$) | kilopascal (kPa) | 6.894 757 | E+00 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| pound-force second per square foot ($lbf•s/ft^2$) | pascal second (Pa•s) | 4.788 026 | E+01 |
| pound-force second per square inch ($lbf•s/in^2$) | pascal second (Pa•s) | 6.894 757 | E+03 |
| pound inch squared ($lb•in^2$) | kilogram meter squared ($kg•m^2$) | 2.926 397 | E-04 |
| pound per cubic foot ($lb/ft^3$) | kilogram per cubic meter ($kg/m^3$) | 1.601 846 | E+01 |
| pound per cubic inch ($lb/in^3$) | kilogram per cubic meter ($kg/m^3$) | 2.767 990 | E+04 |
| pound per cubic yard ($lb/yd^3$) | kilogram per cubic meter ($kg/m^3$) | 5.932 764 | E-01 |
| pound per foot (lb/ft) | kilogram per meter (kg/m) | 1.488 164 | E+00 |
| pound per foot hour [lb/(ft•h)] | pascal second (Pa•s) | 4.133 789 | E-04 |
| pound per foot second [lb/(ft•s)] | pascal second (Pa•s) | 1.488 164 | E+00 |
| pound per gallon [Canadian and U.K. (Imperial)] (lb/gal) | kilogram per cubic meter ($kg/m^3$) | 9.977 637 | E+01 |
| pound per gallon [Canadian and U.K. (Imperial)] (lb/gal) | kilogram per liter (kg/L) | 9.977 637 | E-02 |
| pound per gallon (U.S.) (lb/gal) | kilogram per cubic meter ($kg/m^3$) | 1.198 264 | E+02 |
| pound per gallon (U.S.) (lb/gal) | kilogram per liter (kg/L) | 1.198 264 | E-01 |
| pound per horsepower hour [lb/(hp•h)] | kilogram per joule (kg/J) | 1.689 659 | E-07 |
| pound per hour (lb/h) | kilogram per second (kg/s) | 1.259 979 | E-04 |
| pound per inch (lb/in) | kilogram per meter (kg/m) | 1.785 797 | E+01 |
| pound per minute (lb/min) | kilogram per second (kg/s) | 7.559 873 | E-03 |
| pound per second (lb/s) | kilogram per second (kg/s) | 4.535 924 | E-01 |
| pound per square foot ($lb/ft^2$) | kilogram per square meter ($kg/m^2$) | 4.882 428 | E+00 |
| pound per square inch (*not* pound-force) ($lb/in^2$) | kilogram per square meter ($kg/m^2$) | 7.030 696 | E+02 |
| pound per yard (lb/yd) | kilogram per meter (kg/m) | 4.960 546 | E-01 |
| psi (pound-force per square inch) ($lbf/in^2$) | pascal (Pa) | 6.894 757 | E+03 |
| psi (pound-force per square inch) ($lbf/in^2$) | kilopascal (kPa) | 6.894 757 | E+00 |
| | | | |
| quad ($10^{15}$ $Btu_{IT}$) | joule (J) | 1.055 056 | E+18 |
| quart (U.S. dry) (dry qt) | cubic meter ($m^3$) | 1.101 221 | E-03 |
| quart (U.S. dry) (dry qt) | liter (L) | 1.101 221 | E+00 |
| quart (U.S. liquid) (liq qt) | cubic meter ($m^3$) | 9.463 529 | E-04 |
| quart (U.S. liquid) (liq qt) | liter (L) | 9.463 529 | E-01 |
| | | | |
| *rad* (absorbed dose) (rad) | gray (Gy) | **1.0** | **E-02** |
| *rem* (rem) | sievert (Sv) | **1.0** | **E-02** |
| revolution ® | radian (rad) | 6.283 185 | E+00 |
| revolution per minute (rpm) (r/min) | radian per second (rad/s) | 1.047 198 | E-01 |
| rhe | reciprocal pascal second $(Pa•s)^{-1}$ | **1.0** | **E+01** |
| rod (based on U.S. survey foot) (rd) | meter (m) | 5.029 210 | E+00 |
| *roentgen* ® | coulomb per kilogram (C/kg) | **2.58** | **E-04** |
| rpm (revolution per minute) (r/min) | radian per second (rad/s) | 1.047 198 | E-01 |
| | | | |
| second (angle) (“) | radian (rad) | 4.848 137 | E-06 |
| second (sidereal) | second (s) | 9.972 696 | E-01 |
| shake | second (s) | **1.0** | **E-08** |
| shake | nanosecond (ns) | **1.0** | **E+01** |
| slug (slug) | kilogram (kg) | 1.459 390 | E+01 |
| slug per cubic foot ($slug/ft^3$) | kilogram per cubic meter ($kg/m^3$) | 5.153 788 | E+02 |
| slug per foot second [slug/(ft•s)] | pascal second (Pa•s) | 4.788 026 | E+01 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| square foot ($ft^2$) | square meter ($m^2$) | **9.290 304** | **E-02** |
| square foot per hour ($ft^2/h$) | square meter per second ($m^2/s$) | **2.580 64** | **E-05** |
| square foot per second ($ft^2/s$) | square meter per second ($m^2/s$) | **9.290 304** | **E-02** |
| square inch ($in^2$) | square meter ($m^2$) | **6.4516** | **E-04** |
| square inch ($in^2$) | square centimeter ($cm^2$) | **6.4516** | **E+00** |
| square mile ($mi^2$) | square meter ($m^2$) | 2.589 988 | E+06 |
| square mile ($mi^2$) | square kilometer ($km^2$) | 2.589 988 | E+00 |
| square mile (based on U.S. survey foot) ($mi^2$) | square meter ($m^2$) | 2.589 998 | E+06 |
| square mile (based on U.S. survey foot) ($mi^2$) | square kilometer ($km^2$) | 2.589 998 | E+00 |
| square yard ($yd^2$) | square meter ($m^2$) | 8.361 274 | E-01 |
| statampere | ampere (A) | 3.335 641 | E-10 |
| statcoulomb | coulomb (C) | 3.335 641 | E-10 |
| statfarad | farad (F) | 1.112 650 | E-12 |
| stathenry | henry (H) | 8.987 552 | E+11 |
| statmho | siemens (S) | 1.112 650 | E-12 |
| statohm | ohm (Ω) | 8.987 552 | E+11 |
| statvolt | volt (V) | 2.997 925 | E+02 |
| stere (st) | cubic meter ($m^3$) | **1.0** | **E+00** |
| stilb (sb) | candela per square meter ($cd/m^2$) | **1.0** | **E+04** |
| stokes (St) | meter squared per second ($m^2/s$) | **1.0** | **E-04** |
| | | | |
| tablespoon | cubic meter ($m^3$) | 1.478 676 | E-05 |
| tablespoon | milliliter (mL) | 1.478 676 | E+01 |
| teaspoon | cubic meter ($m^3$) | 4.928 922 | E-06 |
| teaspoon | milliliter (mL) | 4.928 922 | E+00 |
| tex | kilogram per meter (kg/m) | **1.0** | **E-06** |
| therm (EC) | joule (J) | **1.055 06** | **E+08** |
| therm (U.S.) | joule (J) | **1.054 804** | **E+08** |
| ton, assay (AT) | kilogram (kg) | 2.916 667 | E-02 |
| ton, assay (AT) | gram (g) | 2.916 667 | E+01 |
| ton-force (2000 lbf) | newton (N) | 8.896 443 | E+03 |
| ton-force (2000 lbf) | kilonewton (kN) | 8.896 443 | E+00 |
| ton, long (2240 lb) | kilogram (kg) | 1.016 047 | E+03 |
| ton, long, per cubic yard | kilogram per cubic meter ($kg/m^3$) | 1.328 939 | E+03 |
| *ton, metric* (t) | kilogram (kg) | **1.0** | **E+03** |
| tonne (called “metric ton" in U.S.) (t) | kilogram (kg) | **1.0** | **E+03** |
| ton of refrigeration (12 000 $Btu_{IT}/h$) | watt (W) | 3.516 853 | E+03 |
| ton of TNT (energy equivalent) | joule (J) | **4.184** | **E+09** |
| ton register | cubic meter ($m^3$) | 2.831 685 | E+00 |
| ton, short (2000 lb) | kilogram (kg) | 9.071 847 | E+02 |
| ton, short, per cubic yard | kilogram per cubic meter ($kg/m^3$) | 1.186 553 | E+03 |
| ton, short, per hour | kilogram per second (kg/s) | 2.519 958 | E-01 |
| torr (Torr) | pascal (Pa) | 1.333 224 | E+02 |
| | | | |
| unit pole | weber (Wb) | 1.256 637 | E-07 |
| | | | |
| *watt hour* (W•h) | joule (J) | **3.6** | **E+03** |
| *watt per square centimeter* ($W/cm^2$) | watt per square meter ($W/m^2$) | **1.0** | **E+04** |
| watt per square inch ($W/in^2$) | watt per square meter ($W/m^2$) | 1.550 003 | E+03 |
| *watt second* (W•s) | joule (J) | **1.0** | **E+00** |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| yard (yd) | meter (m) | **9.144** | **E-01** |
| *year* (365 days) | second (s) | **3.1536** | **E+07** |
| year (sidereal) | second (s) | 3.155 815 | E+07 |
| year (tropical) | second (s) | 3.155 693 | E+07 |

**TABLE A 9.0**
**FACTORS FOR UNITS LISTED BY KIND OF QUANTITY OR FIELD OF SCIENCE**

FACTORS IN **BOLDFACE** ARE EXACT

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| **ACCELERATION** | | | |
| acceleration of free fall, standard ($g_n$) | meter per second squared ($m/s^2$) | **9.806 65** | **E+00** |
| foot per second squared ($ft/s^2$) | meter per second squared ($m/s^2$) | **3.048** | **E-01** |
| gal (Gal) | meter per second squared ($m/s^2$) | **1.0** | **E-02** |
| inch per second squared ($in/s^2$) | meter per second squared ($m/s^2$) | **2.54** | **E-02** |
| | | | |
| **ANGLE** | | | |
| *degree* (°) | radian (rad) | 1.745 329 | E-02 |
| gon (also called grade) (gon) | radian (rad) | 1.570 796 | E-02 |
| gon (also called grade) (gon) | degree (°) | **9.0** | **E-01** |
| mil | radian (rad) | 9.817 477 | E-04 |
| mil | degree (°) | **5.625** | **E-02** |
| *minute* (') | radian (rad) | 2.908 882 | E-04 |
| revolution (r) | radian (rad) | 6.283 185 | E+00 |
| *second* (") | radian (rad) | 4.848 137 | E-06 |
| | | | |
| **AREA AND SECOND MOMENT OF AREA** | | | |
| acre (based on U.S. survey foot) | square meter ($m^2$) | 4.046 873 | E+03 |
| are (a) | square meter ($m^2$) | **1.0** | **E+02** |
| barn (b) | square meter ($m^2$) | **1.0** | **E-28** |
| circular mil | square meter ($m^2$) | 5.067 075 | E-10 |
| circular mil | square millimeter ($mm^2$) | 5.067 075 | E-04 |
| foot to the fourth power ($ft^4$) | meter to the fourth power ($m^4$) | 8.630 975 | E-03 |
| *hectare* (ha) | square meter ($m^2$) | **1.0** | **E+04** |
| inch to the fourth power ($in^4$) | meter to the fourth power ($m^4$) | 4.162 314 | E-07 |
| square foot ($ft^2$) | square meter ($m^2$) | **9.290 304** | **E-02** |
| square inch ($in^2$) | square meter ($m^2$) | **6.4516** | **E-04** |
| square inch ($in^2$) | square centimeter ($cm^2$) | **6.4516** | **E+00** |
| square mile ($mi^2$) | square meter ($m^2$) | 2.589 988 | E+06 |
| square mile ($mi^2$) | square kilometer ($km^2$) | 2.589 988 | E+00 |
| square mile (based on U.S. survey foot) ($mi^2$) | square meter ($m^2$) | 2.589 998 | E+06 |
| square mile (based on U.S. survey foot) ($mi^2$) | square kilometer ($km^2$) | 2.589 998 | E+00 |
| square yard ($yd^2$) | square meter ($m^2$) | 8.361 274 | E-01 |
| | | | |
| **CAPACITY (see VOLUME)** | | | |
| | | | |
| **DENSITY (that is, MASS DENSITY-see MASS DIVIDED BY VOLUME)** | | | |
| | | | |
| **ELECTRICITY and MAGNETISM** | | | |
| abampere | ampere (A) | **1.0** | **E+01** |
| abcoulomb | coulomb (C) | **1.0** | **E+01** |
| abfarad | farad (F) | **1.0** | **E+09** |
| abhenry | henry (H) | **1.0** | **E-09** |
| abmho | siemens (S) | **1.0** | **E+09** |
| abohm | ohm (Ω) | **1.0** | **E-09** |
| abvolt | volt (V) | **1.0** | **E-08** |
| | | | |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| *ampere hour* (A•h) | coulomb (C) | **3.6** | **E+03** |
| biot (Bi) | ampere (A) | **1.0** | **E+01** |
| EMU of capacitance (abfarad) | farad (F) | **1.0** | **E+09** |
| EMU of current (abampere) | ampere (A) | **1.0** | **E+01** |
| EMU of electric potential (abvolt) | volt (V) | **1.0** | **E-08** |
| EMU of inductance (abhenry) | henry (H) | **1.0** | **E-09** |
| EMU of resistance (abohm) | ohm (Ω) | **1.0** | **E-09** |
| ESU of capacitance (statfarad) | farad (F) | 1.112 650 | E-12 |
| ESU of current (statampere) | ampere (A) | 3.335 641 | E-10 |
| ESU of electric potential (statvolt) | volt (V) | 2.997 925 | E+02 |
| ESU of inductance (stathenry) | henry (H) | 8.987 552 | E+11 |
| ESU of resistance (statohm) | ohm (Ω) | 8.987 552 | E+11 |
| faraday (based on carbon 12) | coulomb (C) | 9.648 534 | E+04 |
| franklin (Fr) | coulomb (C) | 3.335 641 | E-10 |
| gamma ($\gamma$) | tesla (T) | **1.0** | **E-09** |
| gauss (Gs, G) | tesla (T) | **1.0** | **E-04** |
| gilbert (Gi) | ampere (A) | 7.957 747 | E-01 |
| maxwell (Mx) | weber (Wb) | **1.0** | **E-08** |
| mho | siemens (S) | **1.0** | **E+00** |
| oersted (Oe) | ampere per meter (A/m) | 7.957 747 | E+01 |
| *ohm centimeter* (Ω•cm) | ohm meter (Ω•m) | **1.0** | **E-02** |
| ohm circular-mil per foot | ohm meter (Ω•m) | 1.662 426 | E-09 |
| ohm circular-mil per foot | ohm square millimeter per meter ($\Omega \cdot mm^2/m$) | 1.662 426 | E-03 |
| statampere | ampere (A) | 3.335 641 | E-10 |
| statcoulomb | coulomb (C) | 3.335 641 | E-10 |
| statfarad | farad (F) | 1.112 650 | E-12 |
| stathenry | henry (H) | 8.987 552 | E+11 |
| statmho | siemens (S) | 1.112 650 | E-12 |
| statohm | ohm (Ω) | 8.987 552 | E+11 |
| statvolt | volt (V) | 2.997 925 | E+02 |
| unit pole | weber (Wb) | 1.256 637 | E-07 |
| | | | |
| **ENERGY (includes WORK)** | | | |
| British thermal $unit_{IT}$ ($Btu_{IT}$) | joule (J) | 1.055 056 | E+03 |
| British thermal $unit_{th}$ ($Btu_{th}$) | joule (J) | 1.054 350 | E+03 |
| British thermal unit (mean) (Btu) | joule (J) | 1.055 87 | E+03 |
| British thermal unit (39°F) (Btu) | joule (J) | 1.059 67 | E+03 |
| British thermal unit (59°F) (Btu) | joule (J) | 1.054 80 | E+03 |
| British thermal unit (60°F) (Btu) | joule (J) | 1.054 68 | E+03 |
| $calorie_{IT}$ ($cal_{IT}$) | joule (J) | **4.1868** | **E+00** |
| $calorie_{th}$ ($cal_{th}$) | joule (J) | **4.184** | **E+00** |
| calorie (mean) (cal) | joule (J) | 4.190 02 | E+00 |
| calorie (15°C) ($cal_{15}$) | joule (J) | 4.185 80 | E+00 |
| calorie (20°C) ($cal_{20}$) | joule (J) | 4.181 90 | E+00 |
| $calorie_{IT}$, kilogram (nutrition) | joule (J) | **4.1868** | **E+03** |
| $calorie_{th}$, kilogram (nutrition) | joule (J) | **4.184** | **E+03** |
| calorie (mean), kilogram (nutrition) | joule (J) | 4.190 02 | E+03 |
| *electronvolt* (eV) | joule (J) | 1.602 176 | E-19 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| erg (erg) | joule (J) | **1.0** | **E-07** |
| foot poundal | joule (J) | 4.214 011 | E-02 |
| foot pound-force (ft•lbf) | joule (J) | 1.355 818 | E+00 |
| kilocalorie$_{IT}$ (kcal$_{IT}$) | joule (J) | **4.1868** | **E+03** |
| kilocalorie$_{th}$ (kcal$_{th}$) | joule (J) | **4.184** | **E+03** |
| kilocalorie (mean) (kcal) | joule (J) | 4.190 02 | E+03 |
| *kilowatt hour* (kW•h) | joule (J) | **3.6** | **E+06** |
| *kilowatt hour* (kW•h) | megajoule (MJ) | **3.6** | **E+00** |
| quad ($10^{15}$Btu$_{IT}$) | joule (J) | 1.055 056 | E+18 |
| therm (EC) | joule (J) | **1.055 06** | **E+08** |
| therm (U.S.) | joule (J) | **1.054 804** | **E+08** |
| ton of TNT (energy equivalent) | joule (J) | **4.184** | **E+09** |
| watt hour (W•h) | joule (J) | **3.6** | **E+03** |
| watt second (W•s) | joule (J) | **1.0** | **E+00** |
| | | | |
| **ENERGY DIVIDED BY AREA TIME** | | | |
| erg per square centimeter second [erg/(cm$^2$•s)] | watt per square meter (W/m$^2$) | **1.0** | **E-03** |
| *watt per square centimeter* (W/cm$^2$) | watt per square meter (W/m$^2$) | **1.0** | **E+04** |
| watt per square inch (W/in$^2$) | watt per square meter (W/m$^2$) | 1.550 003 | E+03 |
| | | | |
| **FLOW (see MASS DIVIDED BY TIME or VOLUME DIVIDED BY TIME)** | | | |
| | | | |
| **FORCE** | | | |
| dyne (dyn) | newton (N) | **1.0** | **E-05** |
| kilogram-force (kgf) | newton (N) | **9.806 65** | **E+00** |
| kilopond (kilogram-force) (kp) | newton (N) | **9.806 65** | **E+00** |
| kip (1 kip=1000 lbf) | newton (N) | 4.448 222 | E+03 |
| kip (1 kip=1000 lbf) | kilonewton (kN) | 4.448 222 | E+00 |
| ounce (avoirdupois)-force (ozf) | newton (N) | 2.780 139 | E-01 |
| poundal | newton (N) | 1.382 550 | E-01 |
| pound-force (lbf) | newton (N) | 4.448 222 | E+00 |
| pound-force per pound (lbf/lb) (thrust to mass ratio) | newton per kilogram (N/kg) | **9.806 65** | **E+00** |
| ton-force (2000 lbf) | newton (N) | 8.896 443 | E+03 |
| ton-force (2000 lbf) | kilonewton (kN) | 8.896 443 | E+00 |
| | | | |
| **FORCE DIVIDED BY AREA (see PRESSURE)** | | | |
| | | | |
| **FORCE DIVIDED BY LENGTH** | | | |
| pound-force per foot (lbf/ft) | newton per meter (N/m) | 1.459 390 | E+01 |
| pound-force per inch (lbf/in) | newton per meter (N/m) | 1.751 268 | E+02 |
| | | | |
| **HEAT** | | | |
| **Available Energy** | | | |
| British thermal unit$_{IT}$ per cubic foot (Btu$_{IT}$/ft$^3$) | joule per cubic meter (J/m$^3$) | 3.725 895 | E+04 |
| British thermal unit$_{th}$ per cubic foot (Btu$_{th}$/ft$^3$) | joule per cubic meter (J/m$^3$) | 3.723 403 | E+04 |
| British thermal unit$_{IT}$ per pound (Btu$_{IT}$/lb) | joule per kilogram (J/kg) | **2.326** | **E+03** |
| British thermal unit$_{th}$ per pound (Btu$_{th}$/lb) | joule per kilogram (J/kg) | 2.324 444 | E+03 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| calorie$_{IT}$ per gram (cal$_{IT}$/g) | joule per kilogram (J/kg) | **4.1868** | **E+03** |
| calorie$_{th}$ per gram (cal$_{th}$/g) | joule per kilogram (J/kg) | **4.184** | **E+03** |
| | | | |
| **Coefficient of Heat Transfer** | | | |
| | | | |
| British thermal unit$_{IT}$ per hour square foot degree Fahrenheit [Btu$_{IT}$/(h•ft$^2$•°F)] | watt per square meter kelvin [W/(m$^2$•K)] | 5.678 263 | E+00 |
| British thermal unit$_{th}$ per hour square foot degree Fahrenheit [Btu$_{th}$/(h•ft$^2$•°F)] | watt per square meter kelvin [W/(m$^2$•K)] | 5.674 466 | E+00 |
| British thermal unit$_{IT}$ per second square foot degree Fahrenheit [Btu$_{IT}$/(s•ft$^2$•°F)] | watt per square meter kelvin [W/(m$^2$•K)] | 2.044 175 | E+04 |
| British thermal unit$_{th}$ per second square foot degree Fahrenheit [Btu$_{th}$/(s•ft$^2$•°F)] | watt per square meter kelvin [W/(m$^2$•K)] | 2.042 808 | E+04 |
| | | | |
| **Density of Heat** | | | |
| British thermal unit$_{IT}$ per square foot (Btu$_{IT}$/(ft$^2$) | joule per square meter (J/m$^2$) | 1.135 653 | E+04 |
| British thermal unit$_{th}$ per square foot (Btu$_{th}$/(ft$^2$) | joule per square meter (J/m$^2$) | 1.134 893 | E+04 |
| calorie$_{th}$ per square centimeter (cal$_{th}$/cm$^2$) | joule per square meter (J/m$^2$) | **4.184** | **E+04** |
| langley (cal$_{th}$/cm$^2$) | joule per square meter (J/m$^2$) | **4.184** | **E+04** |
| | | | |
| **Density of Heat Flow Rate** | | | |
| British thermal unit$_{IT}$ per square foot hour [Btu$_{IT}$/(ft$^2$•h)] | watt per square meter (W/m$^2$) | 3.154 591 | E+00 |
| British thermal unit$_{th}$ per square foot hour [Btu$_{th}$/(ft$^2$•h)] | watt per square meter (W/m$^2$) | 3.152 481 | E+00 |
| British thermal unit$_{th}$ per square foot-minute [Btu$_{th}$/(ft$^2$•min)] | watt per square meter (W/m$^2$) | 1.891 489 | E+02 |
| British thermal unit$_{IT}$ per square foot second [Btu$_{IT}$/(ft$^2$•s)] | watt per square meter (W/m$^2$) | 1.135 653 | E+04 |
| British thermal unit$_{th}$ per square foot second [Btu$_{th}$/(ft$^2$•s)] | watt per square meter (W/m$^2$) | 1.134 893 | E+04 |
| British thermal unit$_{th}$ per square inch second [Btu$_{th}$/(in$^2$•s)] | watt per square meter (W/m$^2$) | 1.634 246 | E+06 |
| calorie$_{th}$ per square centimeter minute [cal$_{th}$/(cm$^2$•min)] | watt per square meter (W/m$^2$) | 6.973 333 | E+02 |
| calorie$_{th}$ per square centimeter second [cal$_{th}$/(cm$^2$•s)] | watt per square meter (W/m$^2$) | **4.184** | **E+04** |
| | | | |
| **Fuel Consumption** | | | |
| gallon (U.S.) per horsepower hour [gal/(hp•h)] | cubic meter per joule (m$^3$/J) | 1.410 089 | E-09 |
| gallon (U.S.) per horsepower hour [gal/(hp•h)] | liter per joule (L/J) | 1.410 089 | E-06 |
| mile per gallon (U.S.) (mpg) (mi/gal) | meter per cubic meter (m/m$^3$) | 4.251 437 | E+05 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| mile per gallon (U.S.) (mpg) (mi/gal) | kilometer per liter (km/L) | 4.251 437 | E-01 |
| mile per gallon (U.S.) (mpg) (mi/gal) | liter per 100 kilometer (L/100 km) | divide 235.215 by number of miles per gallon | |
| pound per horsepower hour [lb/(hp•h)] | kilogram per joule (kg/J) | 1.689 659 | E-07 |
| | | | |
| **Heat Capacity and Entropy** | | | |
| British thermal unit$_{IT}$ per degree Fahrenheit (Btu$_{IT}$/°F) | joule per kelvin (J/K) | 1.899 101 | E+03 |
| British thermal unit$_{th}$ per degree Fahrenheit (Btu$_{th}$/°F) | joule per kelvin (J/K) | 1.897 830 | E+03 |
| British thermal unit$_{IT}$ per degree Rankine (Btu$_{IT}$/°R) | joule per kelvin (J/K) | 1.899 101 | E+03 |
| British thermal unit$_{th}$ per degree Rankine (Btu$_{th}$/°R) | joule per kelvin (J/K) | 1.897 830 | E+03 |
| | | | |
| **Heat Flow Rate** | | | |
| British thermal unit$_{IT}$ per hour (Btu$_{IT}$/h) | watt (W) | 2.930 711 | E-01 |
| British thermal unit$_{th}$ per hour (Btu$_{th}$/h) | watt (W) | 2.928 751 | E-01 |
| British thermal unit$_{th}$ per minute (Btu$_{th}$/min) | watt (W) | 1.757 250 | E+01 |
| British thermal unit$_{IT}$ per second (Btu$_{IT}$/s) | watt (W) | 1.055 056 | E+03 |
| British thermal unit$_{th}$ per second (Btu$_{th}$/s) | watt (W) | 1.054 350 | E+03 |
| calorie$_{th}$ per minute (cal$_{th}$/min) | watt (W) | 6.973 333 | E-02 |
| calorie$_{th}$ per second (cal$_{th}$/s) | watt (W) | **4.184** | **E+00** |
| kilocalorie$_{th}$ per minute (kcal$_{th}$/min) | watt (W) | 6.973 333 | E+01 |
| kilocalorie$_{th}$ per second (kcal$_{th}$/s) | watt (W) | **4.184** | **E+03** |
| ton of refrigeration (12 000 Btu$_{IT}$/h) | watt (W) | 3.516 853 | E+03 |
| | | | |
| **Specific Heat Capacity and Specific Entropy** | | | |
| British thermal unit$_{IT}$ per pound degree Fahrenheit [Btu$_{IT}$/(lb•°F)] | joule per kilogram kelvin [J/(kg•K)] | **4.1868** | **E+03** |
| British thermal unit$_{th}$ per pound degree Fahrenheit [Btu$_{IT}$/(lb•°F)] | joule per kilogram kelvin [J/(kg•K)] | **4.184** | **E+03** |
| British thermal unit$_{IT}$ per pound degree Rankine [Btu$_{IT}$/(lb•°R)] | joule per kilogram kelvin [J/(kg•K)] | **4.1868** | **E+03** |
| British thermal unit$_{th}$ per pound degree Rankine [Btu$_{th}$/(lb•°R)] | joule per kilogram kelvin [J/(kg•K)] | **4.184** | **E+03** |
| calorie$_{IT}$ per gram degree Celsius [cal$_{IT}$/(g•°C)] | joule per kilogram kelvin [J/(kg•K)] | **4.1868** | **E+03** |
| calorie$_{th}$ per gram degree Celsius [cal$_{th}$/(g•°C)] | joule per kilogram kelvin [J/(kg•K)] | **4.184** | **E+03** |
| calorie$_{IT}$ per gram kelvin [cal$_{IT}$/(g•K)] | joule per kilogram kelvin [J/(kg•K)] | **4.1868** | **E+03** |
| calorie$_{th}$ per gram kelvin [cal$_{th}$/(g•K)] | joule per kilogram kelvin [J/(kg•K)] | **4.184** | **E+03** |
| | | | |
| **Thermal Conductivity** | | | |
| British thermal unit$_{IT}$ foot per hour square foot degree Fahrenheit [Btu$_{IT}$•ft/(h•ft$^2$•°F) | watt per meter kelvin [W/(m•K)] | 1.730 735 | E+00 |
| British thermal unit$_{th}$ foot per hour square foot degree Fahrenheit [Btu$_{th}$•ft/(h•ft$^2$•°F) | watt per meter kelvin [W/(m•K)] | 1.729 577 | E+00 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| British thermal unit$_{IT}$ inch per hour square foot degree Fahrenheit [Btu$_{IT}$•in/(h•ft$^2$•°F) | watt per meter kelvin [W/(m•K)] | 1.442 279 | E-01 |
| British thermal unit$_{th}$ inch per hour square foot degree Fahrenheit [Btu$_{th}$•in/(h•ft$^2$•°F) | watt per meter kelvin [W/(m•K)] | 1.441 314 | E-01 |
| British thermal unit$_{IT}$ inch per second square foot degree Fahrenheit [Btu$_{IT}$•in/(s•ft$^2$•°F) | watt per meter kelvin [W/(m•K)] | 5.192 204 | E+02 |
| British thermal unit$_{th}$ inch per second square foot degree Fahrenheit [Btu$_{th}$•in/(s•ft$^2$•°F) | watt per meter kelvin [W/(m•K)] | 5.188 732 | E+02 |
| calorie$_{th}$ per centimeter second degree Celsius [cal$_{th}$/(cm•s•°C)] | watt per meter kelvin [W/(m•K)] | **4.184** | **E+02** |
| | | | |
| **Thermal Diffusivity** | | | |
| square foot per hour (ft$^2$/h) | square meter per second (m$^2$/s) | **2.580 64** | **E-05** |
| | | | |
| **Thermal Insulance** | | | |
| clo | square meter kelvin per watt (m$^2$•K/W) | 1.55 | E-01 |
| degree Fahrenheit hour square foot per British thermal unit$_{IT}$ (°F•h•ft$^2$/Btu$_{IT}$) | square meter kelvin per watt (m$^2$•K/W) | 1.761 102 | E-01 |
| degree Fahrenheit hour square foot per British thermal unit$_{th}$ (°F•h•ft$^2$/Btu$_{th}$) | square meter kelvin per watt (m$^2$•K/W) | 1.762 280 | E-01 |
| | | | |
| **Thermal Resistance** | | | |
| degree Fahrenheit hour per British thermal unit$_{IT}$ (°F•h/Btu$_{IT}$) | kelvin per watt (K/W) | 1.895 634 | E+00 |
| degree Fahrenheit hour per British thermal unit$_{th}$ (°F•h/Btu$_{th}$) | kelvin per watt (K/W) | 1.896 903 | E+00 |
| degree Fahrenheit second per British thermal unit$_{IT}$ (°F•s/Btu$_{IT}$) | kelvin per watt (K/W) | 5.265 651 | E-04 |
| degree Fahrenheit second per British thermal unit$_{th}$ (°F•s/Btu$_{th}$) | kelvin per watt (K/W) | 5.269 175 | E-04 |
| | | | |
| **Thermal Resistivity** | | | |
| degree Fahrenheit hour square foot per British thermal unit$_{IT}$ inch [°F•h•ft$^2$/(Btu$_{IT}$•in)] | meter kelvin per watt (m•K/W) | 6.933 472 | E+00 |
| degree Fahrenheit hour square foot per British thermal unit$_{th}$ inch [°F•h•ft$^2$/(Btu$_{th}$•in)] | meter kelvin per watt (m•K/W) | 6.938 112 | E+04 |
| | | | |
| **LENGTH** | | | |
| ångström (Å) | meter (m) | **1.0** | **E-10** |
| ångström (Å) | nanometer (nm) | **1.0** | **E-01** |
| *astronomical unit* (ua) | meter (m) | 1.495 979 | E+11 |
| chain (based on U.S. survey foot) (ch) | meter (m) | 2.011 684 | E+01 |
| fathom (based on U.S. survey foot) | meter (m) | 1.828 804 | E+00 |
| fermi | meter (m) | **1.0** | **E-15** |
| fermi | femtometer (fm) | **1.0** | **E+00** |
| foot (ft) | meter (m) | **3.048** | **E-01** |
| foot (U.S. survey) (ft) | meter (m) | 3.048 006 | E-01 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| inch (in) | meter (m) | **2.54** | **E-02** |
| inch (in) | centimeter (cm) | **2.54** | **E+00** |
| kayser (K) | reciprocal meter ($m^{-1}$) | **1** | **E+02** |
| light year (l.y.) | meter (m) | 9.460 73 | E+15 |
| microinch | meter (m) | **2.54** | **E-08** |
| microinch | micrometer (μm) | **2.54** | **E-02** |
| micron (μ) | meter (m) | **1.0** | **E-06** |
| micron (μ) | micrometer (μm) | **1.0** | **E+00** |
| mil (0.001 in) | meter (m) | **2.54** | **E-05** |
| mil (0.001 in) | millimeter (mm) | **2.54** | **E-02** |
| mile (mi) | meter (m) | **1.609 344** | **E+03** |
| mile (mi) | kilometer (km) | **1.609 344** | **E+00** |
| mile (based on U.S. survey foot) (mi) | meter (m) | 1.609 347 | E+03 |
| mile (based on U.S. survey foot) (mi) | kilometer (km) | 1.609 347 | E+00 |
| *mile, nautical* | meter (m) | **1.852** | **E+03** |
| parsec (pc) | meter (m) | 3.085 678 | E+16 |
| pica (computer) (1/6 in) | meter (m) | 4.233 333 | E-03 |
| pica (computer) (1/6 in) | millimeter (mm) | 4.233 333 | E+00 |
| pica (printer's) | meter (m) | 4.217 518 | E-03 |
| pica (printer's) | millimeter (mm) | 4.217 518 | E+00 |
| point (computer) (1/72 in) | meter (m) | 3.527 778 | E-04 |
| point (computer) (1/72 in) | millimeter (mm) | 3.527 778 | E-01 |
| point (printer's) | meter (m) | 3.514 598 | E-04 |
| point (printer's) | millimeter (mm) | 3.514 598 | E-01 |
| rod (based on U.S. survey foot) (rd) | meter (m) | 5.029 210 | E+00 |
| yard (yd) | meter (m) | **9.144** | **E-01** |
| | | | |
| **LIGHT** | | | |
| candela per square inch ($cd/in^2$) | candela per square meter ($cd/m^2$) | 1.550 003 | E+03 |
| footcandle | lux (lx) | 1.076 391 | E+01 |
| footlambert | candela per square meter ($cd/m^2$) | 3.426 259 | E+00 |
| lambert | candela per square meter ($cd/m^2$) | 3.183 099 | E+03 |
| lumen per square foot ($lm/ft^2$) | lux (lx) | 1.076 391 | E+01 |
| phot (ph) | lux (lx) | **1.0** | **E+04** |
| stilb (sb) | candela per square meter ($cd/m^2$) | **1.0** | **E+04** |
| | | | |
| **MASS and MOMENT OF INERTIA** | | | |
| carat, metric | kilogram (kg) | **2.0** | **E-04** |
| carat, metric | gram (g) | **2.0** | **E-01** |
| grain (gr) | kilogram (kg) | **6.479 891** | **E-05** |
| grain (gr) | milligram (mg) | **6.479 891** | **E+01** |
| hundredweight (long, 112 1b) | kilogram (kg) | 5.080 235 | E+01 |
| hundredweight (short, 100 lb) | kilogram (kg) | 4.535 924 | E+01 |
| kilogram-force second squared per meter ($kgf•s^2/m$) | kilogram (kg) | **9.806 65** | E+00 |
| ounce (avoirdupois) (oz) | kilogram (kg) | 2.834 952 | E-02 |
| ounce (avoirdupois) (oz) | gram (g) | 2.834 952 | E+01 |
| ounce (troy or apothecary) (oz) | kilogram (kg) | 3.110 348 | E-02 |
| ounce (troy or apothecary) (oz) | gram (g) | 3.110 348 | E+01 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| pennyweight (dwt) | kilogram (kg) | 1.555 174 | E-03 |
| pennyweight (dwt) | gram (g) | 1.555 174 | E+00 |
| pound (avoirdupois) (lb) | kilogram (kg) | 4.535 924 | E-01 |
| pound (troy or apothecary) (lb) | kilogram (kg) | 3.732 417 | E-01 |
| pound foot squared (lb•ft$^2$) | kilogram meter squared (kg•m$^2$) | 4.214 011 | E-02 |
| pound inch squared (lb•in$^2$) | kilogram meter squared (kg•m$^2$) | 2.926 397 | E-04 |
| slug (slug) | kilogram (kg) | 1.459 390 | E+01 |
| ton, assay (AT) | kilogram (kg) | 2.916 667 | E-02 |
| ton, assay (AT) | gram (g) | 2.916 667 | E+01 |
| ton, long (2240 lb) | kilogram (kg) | 1.016 047 | E+03 |
| *ton, metric* (t) | kilogram (kg) | **1.0** | **E+03** |
| tonne (called “metric ton" in U.S.) (t) | kilogram (kg) | **1.0** | **E+03** |
| ton, short (2000 lb) | kilogram (kg) | 9.071 847 | E+02 |
| | | | |
| **MASS DENSITY (see MASS DIVIDED BY VOLUME)** | | | |
| | | | |
| **MASS DIVIDED BY AREA** | | | |
| ounce (avoirdupois) per square foot (oz/ft$^2$) | kilogram per square meter (kg/m$^2$) | 3.051 517 | E-01 |
| ounce (avoirdupois) per square inch (oz/in$^2$) | kilogram per square meter (kg/m$^2$) | 4.394 185 | E+01 |
| ounce (avoirdupois) per square yard (oz/yd$^2$) | kilogram per square meter (kg/m$^2$) | 3.390 575 | E-02 |
| pound per square foot (lb/ft$^2$) | kilogram per square meter (kg/m$^2$) | 4.882 428 | E+00 |
| pound per square inch (*not* pound force) (lb/in$^2$) | kilogram per square meter (kg/m$^2$) | 7.030 696 | E+02 |
| | | | |
| **MASS DIVIDED BY CAPACITY (see MASS DIVIDED BY VOLUME)** | | | |
| | | | |
| **MASS DIVIDED BY LENGTH** | | | |
| denier | kilogram per meter (kg/m) | 1.111 111 | E-07 |
| denier | gram per meter (g/m) | 1.111 111 | E-04 |
| pound per foot (lb/ft) | kilogram per meter (kg/m) | 1.488 164 | E+00 |
| pound per inch (lb/in) | kilogram per meter (kg/m) | 1.785 797 | E+01 |
| pound per yard (lb/yd) | kilogram per meter (kg/m) | 4.960 546 | E-01 |
| tex | kilogram per meter (kg/m) | **1.0** | **E-06** |
| | | | |
| **MASS DIVIDED BY TIME (includes FLOW)** | | | |
| pound per hour (lb/h) | kilogram per second (kg/s) | 1.259 979 | E-04 |
| pound per minute (lb/min) | kilogram per second (kg/s) | 7.559 873 | E-03 |
| pound per second (lb/s) | kilogram per second (kg/s) | 4.535 924 | E-01 |
| ton, short, per hour | kilogram per second (kg/s) | 2.519 958 | E-01 |
| | | | |
| **MASS DIVIDED BY VOLUME (includes MASS DENSITY and MASS CONCENTRATION)** | | | |
| grain per gallon (U.S.) (gr/gal) | kilogram per cubic meter (kg/m$^3$) | 1.711 806 | E-02 |
| grain per gallon (U.S.) (gr/gal) | milligram per liter (mg/L) | 1.711 806 | E+01 |
| *gram per cubic centimeter* (g/cm$^3$) | kilogram per cubic meter (kg/m$^3$) | **1.0** | **E+03** |
| ounce (avoirdupois) per cubic inch (oz/in$^3$) | kilogram per cubic meter (kg/m$^3$) | 1.729 994 | E+03 |
| ounce (avoirdupois) per gallon [Canadian and U.K. (Imperial)] (oz/gal) | kilogram per cubic meter (kg/m$^3$) | 6.236 023 | E+00 |
| ounce (avoirdupois) per gallon [Canadian and U.K. (Imperial)] (oz/gal) | gram per liter (g/L) | 6.236 023 | E+00 |
| ounce (avoirdupois) per gallon (U.S.) (oz/gal) | kilogram per cubic meter (kg/m$^3$) | 7.489 152 | E+00 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| ounce (avoirdupois) per gallon (U.S.) (oz/gal) | gram per liter (g/L) | 7.489 152 | E+00 |
| pound per cubic foot ($lb/ft^3$) | kilogram per cubic meter ($kg/m^3$) | 1.601 846 | E+01 |
| pound per cubic inch ($lb/in^3$) | kilogram per cubic meter ($kg/m^3$) | 2.767 990 | E+04 |
| pound per cubic yard ($lb/yd^3$) | kilogram per cubic meter ($kg/m^3$) | 5.932 764 | E-01 |
| pound per gallon [Canadian and U.K. (Imperial)] (lb/gal) | kilogram per cubic meter ($kg/m^3$) | 9.977 637 | E+01 |
| pound per gallon [Canadian and UK (Imperial)] (lb/gal) | kilogram per liter (kg/L) | 9.977 637 | E-02 |
| pound per gallon (U.S.) (lb/gal) | kilogram per cubic meter ($kg/m^3$) | 1.198 264 | E+02 |
| pound per gallon (U.S.) (lb/gal) | kilogram per liter (kg/L) | 1.198 264 | E-01 |
| slug per cubic foot ($slug/ft^3$) | kilogram per cubic meter ($kg/m^3$) | 5.153 788 | E+02 |
| ton, long, per cubic yard | kilogram per cubic meter ($kg/m^3$) | 1.328 939 | E+03 |
| ton, short, per cubic yard | kilogram per cubic meter ($kg/m^3$) | 1.186 553 | E+03 |
| | | | |
| **MOMENT OF FORCE OR TORQUE** | | | |
| dyne centimeter (dyn•cm) | newton meter (N•m) | **1.0** | **E-07** |
| kilogram-force meter (kgf•m) | newton meter (N•m) | **9.806 65** | **E+00** |
| ounce (avoirdupois)-force inch (ozf•in) | newton meter (N•m) | 7.061 552 | E-03 |
| ounce (avoirdupois)-force inch (ozf•in) | millinewton meter (mN•m) | 7.061 552 | E+00 |
| pound-force foot (lbf•ft) | newton meter (N•m) | 1.355 818 | E+00 |
| pound-force inch (lbf•in) | newton meter (N•m) | 1.129 848 | E-01 |
| | | | |
| **MOMENT OF FORCE or TORQUE, DIVIDED BY LENGTH** | | | |
| pound-force foot per inch (lbf•ft/in) | newton meter per meter (N•m/m) | 5.337 866 | E+01 |
| pound-force inch per inch (lbf•in/in) | newton meter per meter (N•m/m) | 4.448 222 | E+00 |
| | | | |
| **PERMEABILITY** | | | |
| darcy | meter squared ($m^2$) | 9.869 233 | E-13 |
| perm (0°C) | kilogram per pascal second square meter [$kg/(Pa•s•m^2)$] | 5.721 35 | E-11 |
| perm (23°C) | kilogram per pascal second square meter [$kg / (Pa•s•m^2)$] | 5.745 25 | E-11 |
| perm inch (0°C) | kilogram per pascal second meter [kg/(Pa•s•m)] | 1.453 22 | E-12 |
| perm inch (23°C) | kilogram per pascal second meter [kg/(Pa•s•m)] | 1.459 29 | E-12 |
| | | | |
| **POWER** | | | |
| erg per second (erg/s) | watt (W) | **1.0** | **E-07** |
| foot pound-force per hour (ft•lbf/h) | watt (W) | 3.766 161 | E-04 |
| foot pound-force per minute (ft•lbf/min) | watt (W) | 2.259 697 | E-02 |
| foot pound-force per second (ft•lbf/s) | watt (W) | 1.355 818 | E+00 |
| horsepower (550 ft•lbf/s) | watt (W) | 7.456 999 | E+02 |
| horsepower (boiler) | watt (W) | 9.809 50 | E+03 |
| horsepower (electric) | watt (W) | **7.46** | **E+02** |
| horsepower (metric) | watt (W) | 7.354 988 | E+02 |
| horsepower (U.K.) | watt (W) | 7.4570 | E+02 |
| horsepower (water) | watt (W) | 7.460 43 | E+02 |
| | | | |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| **PRESSURE or STRESS (FORCE DIVIDED BY AREA)** | | | |
| atmosphere, standard (atm) | pascal (Pa) | **1.013 25** | **E+05** |
| atmosphere. standard (atm) | kilopascal (kPa) | **1.013 25** | **E+02** |
| atmosphere, technical (at) | pascal (Pa) | **9.806 65** | **E+04** |
| atmosphere, technical (at) | kilopascal (kPa) | **9.806 65** | **E+01** |
| bar (bar) | pascal (Pa) | **1.0** | **E+05** |
| bar (bar) | kilopascal (kPa) | **1.0** | **E+02** |
| centimeter of mercury (0°C) | pascal (Pa) | 1.333 22 | E+03 |
| centimeter of mercury (0°C) | kilopascal (kPa) | 1.333 22 | E+00 |
| centimeter of mercury, conventional (cmHg) | pascal (Pa) | 1.333 224 | E+03 |
| centimeter of mercury, conventional (cmHg) | kilopascal (kPa) | 1.333 224 | E+00 |
| centimeter of water (4°C) | pascal (Pa) | 9.806 38 | E+01 |
| centimeter of water, conventional ($cmH_2O$) | pascal (Pa) | **9.806 65** | **E+01** |
| dyne per square centimeter ($dyn/cm^2$) | pascal (Pa) | **1.0** | **E-01** |
| foot of mercury, conventional (ftHg) | pascal (Pa) | 4.063 666 | E+04 |
| foot of mercury, conventional (ftHg) | kilopascal (kPa) | 4.063 666 | E+01 |
| foot of water (39.2°F) | pascal (Pa) | 2.988 98 | E+03 |
| foot of water (39.2°F) | kilopascal (kPa) | 2.988 98 | E+00 |
| foot of water, conventional ($ftH_2O$) | pascal (Pa) | 2.989 067 | E+03 |
| foot of water, conventional ($ftH_2O$) | kilopascal (kPa) | 2.989 067 | E+00 |
| gram-force per square centimeter ($gf/cm^2$) | pascal (Pa) | **9.806 65** | **E+01** |
| inch of mercury (32°F) | pascal (Pa) | 3.386 38 | E+03 |
| inch of mercury (32°F) | kilopascal (kPa) | 3.386 38 | E+00 |
| inch of mercury (60°F) | pascal (Pa) | 3.376 85 | E+03 |
| inch of mercury (60°F) | kilopascal (kPa) | 3.376 85 | E+00 |
| inch of mercury, conventional (inHg) | pascal (Pa) | 3.386 389 | E+03 |
| inch of mercury, conventional (inHg) | kilopascal (kPa) | 3.386 389 | E+00 |
| inch of water (39.2°F) | pascal (Pa) | 2.490 82 | E+02 |
| inch of water (60°F) | pascal (Pa) | 2.4884 | E+02 |
| inch of water, conventional ($inH_2O$) | pascal (Pa) | 2.490 889 | E+02 |
| kilogram-force per square centimeter ($kgf/cm^2$) | pascal (Pa) | **9.806 65** | **E+04** |
| kilogram-force per square centimeter ($kgf/cm^2$) | kilopascal (kPa) | **9.806 65** | **E+01** |
| kilogram-force per square meter ($kgf/m^2$) | pascal (Pa) | **9.806 65** | **E+00** |
| kilogram-force per square millimeter ($kgf/mm^2$) | pascal (Pa) | **9.806 65** | **E+06** |
| kilogram-force per square millimeter ($kgf/mm^2$) | megapascal (MPa) | **9.806 65** | **E+00** |
| kip per square inch (ksi) ($kip/in^2$) | pascal (Pa) | 6.894 757 | E+06 |
| kip per square inch (ksi) ($kip/in^2$) | kilopascal (kPa) | 6.894 757 | E+03 |
| millibar (mbar) | pascal (Pa) | **1.0** | **E+02** |
| millibar (mbar) | kilopascal (kPa) | **1.0** | **E-01** |
| millimeter of mercury, conventional (mmHg) | pascal (Pa) | 1.333 224 | E+02 |
| millimeter of water, conventional ($mmH_2O$) | pascal (Pa) | **9.806 65** | **E+00** |
| poundal per square foot | pascal (Pa) | 1.488 164 | E+00 |
| pound-force per square foot ($lbf/ft^2$) | pascal (Pa) | 4.788 026 | E+01 |
| pound-force per square inch (psi) ($lbf/in^2$) | pascal (Pa) | 6.894 757 | E+03 |
| pound-force per square inch (psi) ($lbf/in^2$) | kilopascal (kPa) | 6.894 757 | E+00 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| psi (pound-force per square inch) ($lbf/in^2$) | pascal (Pa) | 6.894 757 | E+03 |
| psi (pound-force per square inch) ($lbf/in^2$) | kilopascal (kPa) | 6.894 757 | E+00 |
| torr (Torr) | pascal (Pa) | 1.333 224 | E+02 |
| | | | |
| **RADIOLOGY** | | | |
| *curie* (Ci) | becquerel (Bq) | **3.7** | **E+10** |
| *rad* (absorbed dose) (rad) | gray (Gy) | **1.0** | **E-02** |
| *rem* (rem) | sievert (Sv) | **1.0** | **E-02** |
| *roentgen* (R) | coulomb per kilogram (C/kg) | **2.58** | **E-04** |
| | | | |
| **SPEED (see VELOCITY)** | | | |
| | | | |
| **STRESS (see PRESSURE)** | | | |
| | | | |
| **TEMPERATURE** | | | |
| *degree Celsius* (°C) | kelvin (K) | K=°C+**273.15** | |
| degree centigrade | degree Celsius (°C) | °C≈deg. cent. | |
| degree Fahrenheit (°F) | degree Celsius (°C) | °C=(°F-**32**)/**1.8** | |
| degree Fahrenheit (°F) | kelvin (K) | K=(°F+**459.67**)/**1.8** | |
| degree Rankine (°R) | kelvin (K) | K=(°R)/**1.8** | |
| *kelvin* (K) | degree Celsius (°C) | °C=K-**273.15** | |
| | | | |
| **TEMPERATURE INTERVAL** | | | |
| *degree Celsius* (°C) | kelvin (K) | **1.0** | **E+00** |
| degree centigrade | degree Celsius (°C) | 1.0 | E+00 |
| degree Fahrenheit (°F) | degree Celsius (°C) | 5.555 556 | E-01 |
| degree Fahrenheit (°F) | kelvin (K) | 5.555 556 | E-01 |
| degree Rankine (°R) | Kelvin (K) | 5.555 556 | E-01 |
| | | | |
| **TIME** | | | |
| *day* (d) | second (s) | **8.64** | **E+04** |
| day (sidereal) | second (s) | 8.616 409 | E+04 |
| *hour* (h) | second (s) | **3.6** | **E+03** |
| hour (sidereal) | second (s) | 3.590 170 | E+03 |
| *minute* (min) | second (s) | **6.0** | **E+01** |
| minute (sidereal) | second (s) | 5.983 617 | E+01 |
| second (sidereal) | second (s) | 9.972 696 | E-01 |
| shake | second (s) | **1.0** | **E-08** |
| shake | nanosecond (ns) | **1.0** | **E+01** |
| year (365 days) | second (s) | **3.1536** | **E+07** |
| year (sidereal) | second (s) | 3.155 815 | E+07 |
| year (tropical) | second (s) | 3.155 693 | E+07 |
| | | | |
| **TORQUE (see MOMENT OF FORCE)** | | | |
| | | | |
| **VELOCITY (includes SPEED)** | | | |
| foot per hour (ft/h) | meter per second (m/s) | 8.466 667 | E-05 |
| foot per minute (ft/min) | meter per second (m/s) | **5.08** | **E-03** |
| foot per second (ft/s) | meter per second (m/s) | **3.048** | **E-01** |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| inch per second (in/s) | meter per second (m/s) | **2.54** | **E-02** |
| *kilometer per hour* (km/h) | meter per second (m/s) | 2.777 778 | E-01 |
| *knot* (nautical mile per hour) | meter per second (m/s) | 5.144 444 | E-01 |
| mile per hour (mi/h) | meter per second (m/s) | **4.4704** | **E-01** |
| mile per hour (mi/h) | kilometer per hour (km/h) | **1.609 344** | **E+00** |
| mile per minute (mi/min) | meter per second (m/s) | **2.682 24** | **E+01** |
| mile per second (mi/s) | meter per second (m/s) | **1.609 344** | **E+03** |
| revolution per minute (rpm) (r/min) | radian per second (rad/s) | 1.047 198 | E-01 |
| rpm (revolution per minute) (r/min) | radian per second (rad/s) | 1.047 198 | E-01 |
| | | | |
| **VISCOSITY, DYNAMIC** | | | |
| centipoise (cP) | pascal second (Pa•s) | **1.0** | **E-03** |
| poise (P) | pascal second (Pa•s) | **1.0** | **E-01** |
| poundal second per square foot | pascal second (Pa•s) | 1.488 164 | E+00 |
| pound-force second per square foot ($lbf•s/ft^2$) | pascal second (Pa•s) | 4.788 026 | E+01 |
| pound-force second per square inch ($lbf•s/in^2$) | pascal second (Pa•s) | 6.894 757 | E+03 |
| pound per foot hour [lb/(ft•h)] | pascal second (Pa•s) | 4.133 789 | E-04 |
| pound per foot second [lb/(ft•s)] | pascal second (Pa•s) | 1.488 164 | E+00 |
| rhe | reciprocal pascal second $(Pa•s)^{-1}$ | **1.0** | **E+01** |
| slug per foot second [slug/(ft•s)] | pascal second (Pa•s) | 4.788 026 | E+01 |
| | | | |
| **VISCOSITY, KINEMATIC** | | | |
| centistokes (cSt) | meter squared per second ($m^2/s$) | **1.0** | **E-06** |
| square foot per second ($ft^2/s$) | meter squared per second ($m^2/s$) | **9.290 304** | **E-02** |
| stokes (St) | meter squared per second ($m^2/s$) | **1.0** | **E-04** |
| | | | |
| **VOLUME (includes CAPACITY)** | | | |
| acre-foot (based on U.S. survey foot) | cubic meter ($m^3$) | 1.233 489 | E+03 |
| barrel [for petroleum, 42 gallons (U.S.)](bbl) | cubic meter ($m^3$) | 1.589 873 | E-01 |
| barrel [for petroleum, 42 gallons (U.S.)](bbl) | liter (L) | 1.589 873 | E+02 |
| bushel (U.S.) (bu) | cubic meter ($m^3$) | 3.523 907 | E-02 |
| bushel (U.S.) (bu) | liter (L) | 3.523 907 | E+01 |
| cord (128 $ft^3$) | cubic meter ($m^3$) | 3.624 556 | E+00 |
| cubic foot ($ft^3$) | cubic meter ($m^3$) | 2.831 685 | E-02 |
| cubic inch ($in^3$) | cubic meter ($m^3$) | 1.638 706 | E-05 |
| cubic mile ($mi^3$) | cubic meter ($m^3$) | 4.168 182 | E+09 |
| cubic yard ($yd^3$) | cubic meter ($m^3$) | 7.645 549 | E-01 |
| cup (U.S.) | cubic meter ($m^3$) | 2.365 882 | E-04 |
| cup (U.S.) | liter (L) | 2.365 882 | E-01 |
| cup (U.S.) | milliliter (mL) | 2.365 882 | E+02 |
| fluid ounce (U.S.) (fl oz) | cubic meter ($m^3$) | 2.957 353 | E-05 |
| fluid ounce (U.S.) (fl oz) | milliliter (mL) | 2.957 353 | E+01 |
| gallon [Canadian and U.K. (Imperial)] (gal) | cubic meter ($m^3$) | **4.546 09** | **E-03** |
| gallon [Canadian and U.K. (Imperial)] (gal) | liter (L) | **4.546 09** | **E+00** |
| gallon (U.S. liquid) (gal) | cubic meter ($m^3$) | 3.785 412 | E-03 |
| gallon (U.S. liquid) (gal) | liter (L) | 3.785 412 | E+00 |
| gill [Canadian and UK (Imperial)] (gi) | cubic meter ($m^3$) | 1.420 653 | E-04 |

**TABLE A 9.0 continued**

| TO CONVERT FROM | TO | MULTIPLY BY | |
|---|---|---|---|
| | | | |
| gill [Canadian and UK (Imperial)] (gi) | liter (L) | 1.420 653 | E-01 |
| gill (U.S.) (gi) | cubic meter ($m^3$) | 1.182 941 | E-04 |
| gill (U.S.) (gi) | liter (L) | 1.182 941 | E-01 |
| *liter* (L) | cubic meter ($m^3$) | **1.0** | **E-03** |
| ounce [Canadian and U.K. fluid (Imperial)] (fl oz) | cubic meter ($m^3$) | 2.841 306 | E-05 |
| ounce [Canadian and U.K. fluid (Imperial)] (fl oz) | milliliter (mL) | 2.841 306 | E+01 |
| ounce (U.S. fluid) (fl oz) | cubic meter ($m^3$) | 2.957 353 | E-05 |
| ounce (U.S. fluid) (fl oz) | milliliter (mL) | 2.957 353 | E+01 |
| peck (U.S.) (pk) | cubic meter ($m^3$) | 8.809 768 | E-03 |
| peck (U.S.) (pk) | liter (L) | 8.809 768 | E+00 |
| pint (U.S. dry) (dry pt) | cubic meter ($m^3$) | 5.506 105 | E-04 |
| pint (U.S. dry) (dry pt) | liter (L) | 5.506 105 | E-01 |
| pint (U.S. liquid) (liq pt) | cubic meter ($m^3$) | 4.731 765 | E-04 |
| pint (U.S. liquid) (liq pt) | liter (L) | 4.731 765 | E-01 |
| quart (U.S. dry) (dry qt) | cubic meter ($m^3$) | 1.101 221 | E-03 |
| quart (U.S. dry) (dry qt) | liter (L) | 1.101 221 | E+00 |
| quart (U.S. liquid) (liq qt) | cubic meter ($m^3$) | 9.463 529 | E-04 |
| quart (U.S. liquid) (liq qt) | liter (L) | 9.463 529 | E-01 |
| stere (st) | cubic meter ($m^3$) | **1.0** | **E+00** |
| tablespoon | cubic meter ($m^3$) | 1.478 676 | E-05 |
| tablespoon | milliliter (mL) | 1.478 676 | E+01 |
| teaspoon | cubic meter ($m^3$) | 4.928 922 | E-06 |
| teaspoon | milliliter (mL) | 4.928 922 | E+00 |
| ton, register | cubic meter ($m^3$) | 2.831 685 | E+00 |
| | | | |
| **VOLUME DIVIDED BY TIME (includes FLOW)** | | | |
| cubic foot per minute ($ft^3$/min) | cubic meter per second ($m^3$/s) | 4.719 474 | E-04 |
| cubic foot per minute ($ft^3$/min) | liter per second (L/s) | 4.719 474 | E-01 |
| cubic foot per second ($ft^3$/s) | cubic meter per second ($m^3$/s) | 2.831 685 | E-02 |
| cubic inch per minute ($in^3$/min) | cubic meter per second ($m^3$/s) | 2.731 177 | E-07 |
| cubic yard per minute ($yd^3$/min) | cubic meter per second ($m^3$/s) | 1.274 258 | E-02 |
| gallon (U.S.) per day (gal/d) | cubic meter per second ($m^3$/s) | 4.381 264 | E-08 |
| gallon (U.S.) per day (gal/d) | liter per second (L/s) | 4.381 264 | E-05 |
| gallon (U.S.) per minute (gpm) (gal/min) | cubic meter per second ($m^3$/s) | 6.309 020 | E-05 |
| gallon (U.S.) per minute (gpm) (gal/min) | liter per second (L/s) | 6.309 020 | E-02 |
| | | | |
| **WORK (see ENERGY)** | | | |

**A 10.0 Nominal Pipe Sizes.** Table A 10.0 shall be used when providing the metric equivalent for nominal pipe sizes.

| TABLE A 10.0<br>NPS "NOMINAL PIPE SIZE" | |
|---|---|
| **DIAMETER NOMINAL<br>– DN –<br>(mm)** | **NOMINAL PIPE SIZE<br>– NPS –<br>(inches)** |
| 6 | 1/8 |
| 8 | 1/4 |
| 10 | 3/8 |
| 15 | 1/2 |
| 20 | 3/4 |
| 25 | 1 |
| 32 | 1 1/4 |
| 40 | 1 1/2 |
| 50 | 2 |
| 65 | 2 1/2 |
| 80 | 3 |
| 100 | 4 |
| 150 | 6 |
| 200 | 8 |
| 250 | 10 |
| 300 | 12 |
| 350 | 14 |
| 400 | 16 |
| 450 | 18 |
| 500 | 20 |
| 550 | 22 |
| 600 | 24 |
| 650 | 26 |
| 700 | 28 |
| 750 | 30 |
| 800 | 32 |
| 900 | 36 |
| 1000 | 40 |
| 1100 | 42 |
| 1200 | 48 |
| 1400 | 54 |
| 1500 | 60 |
| 1600 | 64 |
| 1800 | 72 |
| 2000 | 80 |
| 2200 | 88 |

**A 11.0 Preferred Spelling.** The following is a list of preferred spelling and punctuation for troublesome "plumbing or mechanical" words that frequently appear in IAPMO documents:

aboveground
absolute
absolute temperature
absorption
access door
accessory
acid proof
aerator fitting
air break
airgap
airtight
anti-scald valve
antisiphon
back-outlet ell
backpressure
backsiphonage
ballcock, antisiphon
ball valve
belowground
cast iron soil pipe
check valves
cleanout
cold rolled steel
copper lined tank
countersink
cross-connection control
deaerator
demineralization
draft controls
draft diverter
draft hood
drain tile
drain valve
drainpipe
drop ell
dynamic head
dynamic pressure
electric type automatic valve
enameled ware
energy cutoff valve
escutcheon
essentially nontoxic transfer fluids
fill valve
fire-activated system
fire alarm
fire fighter
fire-fighting equipment
fire apparatus
fire damper
fire-extinguishing equipment
fireplace
fireproof, fireproofing
fire-protective systems
fire-rated equipment
fire-resistant material
fire-resistive coating
fire-suppressing device
fire suppression
flood level
flood level rim
flushometer or flushometer valve
frost proof
gage=thickness
gastight
gauge=instrument
gray iron
hose bibb
hose bibb backflow preventer
hose bibb vacuum breaker
hubless cast iron soil pipe
hub type soil pipe
hydrodynamics
hydromechanics
influent
hydromechanical
insanitary=instead of unsanitary
interconnection
inverted joint
lap joint
lap weld
load-bearing
low water cutoff
microorganism
multipurpose
nonabsorbent
non-potable water or system
non-siphon trap
noncombustible
noncompliance
nonhealth hazard
nonmandatory
nonpotable
nontoxic
on-site
overall
pH
polyvinyl chloride
p-trap
resealing trap
retrofitting
roughing-in
safety shutoff device
screw thread joint
self-actuated
self-closing faucet
self-scouring flow
self-siphonage
side outlet ell
side outlet tee
slip joint
slip-on flange
spill-resistant
tailpiece
test plug
underground
test ball
wall-hung water closet
wastewater
water hammer arrester
waterlogged
waterborne disease
watertight
watertight joint
waterway
water well-
casing
workspace